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4 February 1985

USSR Report

SPACE

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[III - USSR - 21L S&T]

INTERPLANETARY SCIENCES

VALUE OF PHYSICIAN AT'KOV'S ROLE IN 'SALYUT-7' MISSION

Moscow PRAVDA in Russian 25 Oct 84 p 3

[Article by Ye. Chazov, academician]

[Abstract] The author discusses how space medicine and biology benefited from the inclusion of a physician, Candidate of Medical Sciences O. At'kov, in the crew of the latest long-term mission on the orbiting scientific station "Salyut-7". He refers to At'kov in the article as 'my pupil'.

At'kov's work on the mission both as a researcher and as a crew physician is characterized. It is noted that he conducted more than 200 experiments. Among them, the author says the experiment "Genom" (genome), which involved electrophoretic separation of heavy fragments of DNA, was particularly successful. Comments are also made on the experiment "Membrana", which investigated the loss of calcium through cell membranes. It is noted that this experiment was conducted simultaneously in space and on Earth, under similar temperature conditions.

Discussing the advantages of having a space crew physician, the author notes such things as being able to take blood samples from the veins. Also, it was possible on this mission to make a decision on a more efficient regimen of physical exercise in preparation for the re-encounter with Earth's gravity after the long period in space. The time of the daily exercise period was cut back, while the level of exertion was increased. The author says this was only possible with the presence of a physician to directly assess the cosmonauts' condition.

FTD/SNAP
CSO: 1866/55

TASS UPDATE ON UNMANNED FLIGHT OF 'SALYUT-7'

Moscow IZVESTIYA in Russian 20 Dec 84 p 1

[TASS Report]

[Text] Flight Control Center, December 19. The scientific station "Salyut-7" has been functioning in low orbit for 32 months. Today as of 1200 hours Moscow time it had made 15,407 revolutions around the Earth.

In line with a program, tests of onboard systems and units of the station which has been in space flight for a long time are continuing. Instruments for monitoring meteor conditions in near-Earth space, and a number of other scientific instruments are functioning. The Flight Control Center is processing and studying the information that is being received.

According to results of trajectory measurements, the oribt parameters of the "Salyut-7" station at the present time are: maximum distance from the Earth's surface -- 387 kilometers; minimum distance from the Earth's surface -- 366 kilometers; period of revolution -- 91.8 minutes; inclination -- 51.6 degrees.

The station's onboard systems are functioning normally.

FTD/SNAP
CSO: 18600/55

RELATION OF MANNED, AUTOMATIC EQUIPMENT IN SPACE PROGRAMS VIEWED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 84 pp 19-25

[Article by Hero of the Soviet Union, USSR Pilot-Cosmonaut, Candidate of Technical Sciences Yu. N. Glazkov and Ye. I. Zhuk: "Man and Automaton in Space"]

[Text] To whom should preference be given in controlling space devices, to man or to an automaton? This question has stirred specialists even since the dawn of the first manned flights in space and it has not lost its pertinence at present.

The "man and automaton" problem is being solved in many sectors of human activity such as production management, in scientific research and everyday life. But this problem is most vividly expressed, probably, in space, on board orbital facilities. Certainly the cosmonaut should be able to operate the onboard equipment of the craft, control its movement, conduct scientific experiments and utilize the life support systems. The specific features of a space flight and primarily weightlessness, the confined space, the diversity of instruments, vibration, noise and acceleration--all of this influences the relationships of man and the automaton. For this reason particular significance is assumed by the optimum distribution of the functions of the man and the automaton in individual stages of a space flight.

At one time the mere contemplation of the starry skies led to an intelligent analysis of the celestial bodies and in time man began to use stars in navigation. The initially simple instruments gradually acquired new advancements which increased the accuracy of the measurements. Having studied the upper strata of the atmosphere using probes, balloons and meteorological rockets, people began to study space using earth satellites. The research has been carried out in two basic areas: the conquering of space by unmanned and manned spacecraft.

Man and Unmanned Space Flights

Just what the interaction of man and the automaton has been in the use of unmanned craft can be traced from the example of the flight of the third earth satellite. It carried instruments which recorded various parameters of the

surrounding medium: for example, pressure and composition of the upper atmosphere, the concentration of positive ions, the electrical charge of the satellite, the intensity of the sun's corpuscular radiation and the composition and variation of the primary cosmic rays. The measurement data were transmitted to the earth by a multichannel telemetric system. Then the obtained information was turned over to the specialist. But only a one-way linkage was inherent to the closed earth--space--earth system and this was from the satellite to man. Here the automaton operated as if independently, not being subordinate in orbit to the will and desire of man. Due to the lack of an appropriate system on the satellite, it was impossible from the ground to reorient the satellite in order to increase the effectiveness of the research and this substantially limited the research generally and man's possibilities, in particular. Cosmos-23 and the subsequent satellites were then outfitted with an orientation and stabilization system and for this reason it was possible to control their position, stabilizing it from commands from the earth.

The appearance of maneuvering satellites immediately altered the relationships between man and the automaton. The stages of interaction became the following: the orbiting of the satellites, the changing in the parameters of orbital motion, the processing of obtained data by a ground computer installation, the giving of the necessary commands to the satellite and their processing by the onboard automation, maneuvering and reorientation of the satellite and stabilization in this position, the carrying out of scientific research and the obtaining of information.

In this system the possibilities of man are significantly broadened, he is a more active element and can control the satellite in orbit and remotely alter its attitude and altitude of flight.

Later research was initiated related to human activity under spaceflight conditions and the onboard systems of the spacecraft were improved and became more complex. Then spacecraft appeared with re-entry capsules. In this instance man, in addition to extensive telemetric information, obtained as it were "direct" material from the space research and this was very important for medical and biological research. Thus, during the flight of the Cosmos-110 satellite, a container was returned to earth with the space research material (ZEMLYA I VSELENNAYA, 1966, No 4, p 59.--Editors).

Manned Space Flight

With the first flight of man in space, the flight of Yu. A. Gagarin, the combined work of man and the automaton immediately increased the effectiveness of the space research. But at the various stages of manned cosmonautics, their interaction has varied and here it is essential to bear in mind the advantages and shortcomings of both "sides."

Both overcooling and overheating are dangerous for the human organism as the cooling of the body below 25° C and warming over 43° C can lead to a fatality. Also limited for man is the G-load limit which is around 20 units. As for electronic equipment, here, of course, broader temperature fluctuations are possible; it maintains its "workability" with gigantic accelerations, it normally functions outside the airtight compartments of the spacecraft, without even

mentioning that it surpasses man in terms of speed and accuracy. Recently in cosmonautics they have begun to employ onboard digital computers (ODC) which have indisputable advantages in terms of speed, accuracy and the volume of individual signals received, in terms of the handling capacity of incoming information and in terms of the capacity to carry out calculations. While a nerve cell requires 10^{-2} seconds to perceive a unit of information, a computer circuit requires only 10^{-7} seconds, that is, 100,000-fold less. Moreover, man grows tired and requires periodic rest, he is unable to concentrate for a long time and is subject to stress and various subjective factors.

But man, although requiring additional systems which provide his vital activities and safety, has come to hold a firm place in the spacecraft and has become an active link in the chain of command of many processes. Certainly man possesses unique properties which do not exist in automata. Man's visual analyzer better senses weak changes and is better adapted to the effective identification of various images, for example, the characteristic configurations of the constellations. Relying precisely on visual observations by cosmonauts, it has been possible to identify vortical formations in the world ocean and link these phenomena with fishery problems (ZEMLYA I VSELENNAYA, 1970, No 1, p 40.--Editors). From a large flow of information man is capable of more effectively isolating the most crucial. He can retain a large amount of information in his memory with a volume of hundreds of millions of bits and at the required moment rapidly retrieve it. Among the indisputed advantages of man one must also put that he better than an automaton services and repairs the inflight systems and instruments. For example, on Salyut-5, the cosmonauts successfully restored the workability of one of the computer complexes. On the orbital station Salyut-6, V. A. Lyakhov and V. V. Ryumin went out into open space and brilliantly performed the operation of freeing an unsuccessfully released antenna while L. D. Kizim, O. G. Makarov and G. M. Strekalov repaired the temperature control system (ZEMLYA I VSELENNAYA, 1979, No 3; 1981, No 1.--Editors). On the orbital complex Salyut-7--Soyuz T-9, cosmonauts V. A. Lyakhov and A. P. Aleksandrov carried out unique work in open space. They installed additional solar batteries and this made it possible to increase the supply of electric power to the orbital complex and thereby broaden the possibilities for carrying out various tasks of the spaceflight program. On unmanned spacecraft and orbital stations it would simply have been impossible to perform the entire range of the designated geophysical, astrophysical, technological, physicotechnical and medical-biological research and experiments. Their results are now being used by the scientific research and production organizations of various national economic sectors.

Spacecraft Control Modes

During a flight the cosmonauts are involved with various systems of the spacecraft itself or a station (control systems, radio communications, life support, the telemetric system and so forth) and a diversity of scientific equipment. Here the optimum distribution of functions between man and the automaton becomes crucial.

Human activities in a space flight are a closed circuit element in the spacecraft control system. How the crew performs this role in this system determines the control modes or conditions: manual, combined, semiautomatic and automatic.

Manual conditions are where the cosmonauts themselves, without the involvement of the inflight automation, achieve a certain control goal. For example, they can set a given orientation, maneuver in orbit, conduct scientific experiments, or service and operate the spacecraft or station.

With a combined mode, both the cosmonauts and automata are involved in the control. In this instance the crew directly influences the work of the automaton, setting a certain mode for it and in addition the crew monitors the work of the automaton, alerts and prevents emergencies and discovers malfunctions. If for some reason the automaton cannot carry out the control task, the crew can switch over to a manual mode.

A semi-automatic control mode is a higher development level of the "crew--spacecraft" system as the automaton gives the crew command information which is used by the crew for forming a control action. An example of such a control system would be the test flight of the Soyuz T-2 transport spacecraft during the course of which the cosmonauts Yu. V. Malyshev and V. V. Aksenov successfully tested a new spacecraft of the Soyuz T series in a manned variation (ZEMLYA I VSELENNAYA, 1980, No 5.--Editors). On board was an ODC and for this reason a semi-automatic mode was proposed for docking with the Salyut-6 orbital station. The cosmonauts carefully monitored the work of the ODC, they analyzed the produced command information and on the basis of this took the appropriate decisions. At a distance of 400 m from the station, the crew shifted to a manual mooring and docking mode. The flight showed that the ODC can successfully control the spacecraft and on the Soyuz T-3 spacecraft they employed an automatic mode for closing and docking with the Salyut-6 station.

In an automatic control mode, the controlling action is generated exclusively by the automaton. The crew organizes and monitors its work and, if need be, switches the "crew--spacecraft" system to other modes.

Under the actual conditions of a spaceflight, the crew works together with all the onboard systems and for this reason the various operating modes of the "crew--spacecraft" system are excellently combined. For example, in conducting the extensive scientific research program on board the orbital complex Salyut-7--Soyuz T, cosmonauts A. V. Berezovoy and V. V. Lebedev rightly considered the Delta autonomous navigation system to be the third crew member. The Delta provided them with great help with any essential orientation of the orbital complex and in producing ballistic and navigational information. Precisely the use of Delta in the various control modes ensured during the flight maximum effectiveness of the "crew--spacecraft" system.

Man and Automaton in the First Space Flights

Let us examine how the allocation of functions between man and the automaton has changed in controlling a spacecraft during various stages of the development of cosmonautics.

During the first flights the main subject of study was the effect of spaceflight factors on the human organism and for this reason preference was then given to the automaton. Still, even with the flight of G. S. Titov, experiments started on manual control of the ship and these gradually were broadened on the Voskhod

Diagram of Manual Control Mode

Cosmonauts themselves, without involvement of onboard automation, perform operations of controlling spacecraft.

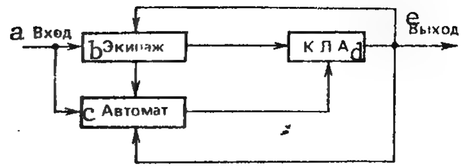


Diagram of Combined Mode of Control

Both cosmonauts and automata involved in control. Crew directly influences the work of automaton, setting a certain mode for it, monitoring its work, discovering malfunctions and so forth.

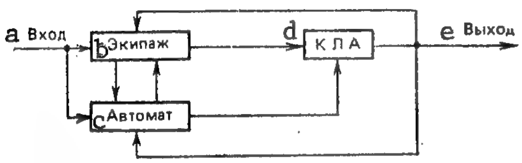


Diagram of Semi-Automatic Control Mode

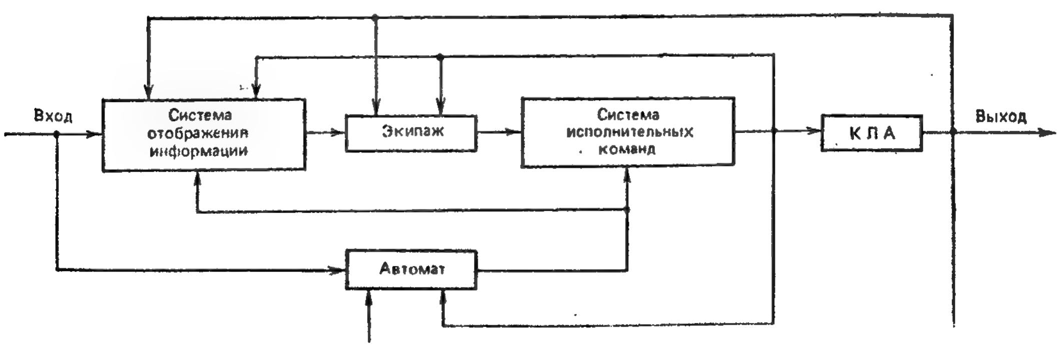
Crew receives command information from automaton and uses it for control.

Diagram of Automatic Control Mode

Control action carried out by automaton. Crew organizes and monitors its work and when necessary shifts the "crew--spacecraft" system to other control modes.

Key:

a--Input
b--Crew
c--Automaton
d--Spacecraft
e--Output



Generalized Schematic Diagram of "Crew--Spacecraft" System

Here various modes of its work are combined.

Key: a-e--Same as above
f--Data display system
g--Actuating command system

and Soyuz ships. The capabilities of the cosmonaut to stabilize the craft in operating the retrorocket were tested out during the flight of the Voskhod-2 ship. Its commander, P. I. Belyayev, carried out the attitude control and subsequent stabilization after firing the engine, using the manual control system. In this instance manual control was unnecessary as in operating the retrorocket a disturbing moment was applied to the craft and the cosmonaut had to perform operations with very high accuracy and great stress, as well as constantly monitor the attitude in the process of the engine's firing and parry the disturbing moment. For this reason, on all the Soyuzes, the function of stabilizing the ship during the operating of the docking-adjusting engine during the descent and in maneuvering were turned over to the automaton while a system of manual control was provided only as an alternate variation for increasing the reliability of the "crew--spacecraft" system. Subsequently, no space flight dispensed with the participation of the cosmonauts in controlling the craft, that is, all the designated modes of controlling it began to be successfully employed.

Work on Manned Orbital Complexes

Extended flights on manned orbital complexes showed that even after an extended stay under the conditions of weightlessness and in limited spaces of the station, the crew maintains high workability and stable control skills. But the extensive program of scientific experiments with the active involvement of the crew demands that the cosmonauts be freed of performing simple and frequently repeating operations in the control of the orbital complex. Thus, at present, great importance is being assumed by the problem of the rational allocation of functions between the crew and the automatic devices in the control systems of the spacecraft and orbital stations. The question is being resolved in such a manner that in all crucial operations relating to control which under nominal conditions or, as they say, in a regular variation, are to be done automatically, the possibility should be kept of switching to alternate control modes, either semi-automatic, combined or manual.

In designing the control systems for the manned spacecraft, there have long been two opposing and even contradictory trends: on the one hand, the desire, wherever possible, to free the crew and put as many control functions as possible on the automatic equipment, and on the other, to make maximum use of human capabilities for increasing the effective execution of control tasks. In truth, the balance between these trends has changed constantly both due to the advances in technology and also due to the development of human capabilities. An important role is also played by the level of our knowledge on human capabilities and the interaction of its individual organs and systems of the organism. The problem of the rational allocation of functions between the crew and the automatic devices is not only a question of to whom preference should be given in controlling the spacecraft, that is, to the automaton or to man. It also includes the questions of constructing various control modes which ensure the most effective performance of the given operation.

Supporting the extended existence of orbital manned complexes involves a large number of launched spacecraft, both manned and unmanned. In delivering the crews to the orbital units and in logistical support for the flight, the task of the docking of the craft becomes very acute. And here the optimum allocation of functions between man and automaton is particularly apparent. Depending

upon the specific conditions for the rendezvous and docking of the craft to the station, the docking can be performed under different control modes. But still the automatic rendezvous mode has been adopted as the basic one.

An automatic recovery-from-orbit mode has also been adopted as the basic one. But the use of computers on modern spacecraft has also made it possible to provide a manual descent control mode on the Soyuz T spacecraft as this makes it possible for the cosmonauts to utilize the aerodynamic forces created in the flight of the descending craft in the atmosphere for landing the ship in the designated area. The possibility of combining automatic and manual control modes for the descent has significantly increased the reliability of the "crew--spacecraft" system on this leg.

In describing the role of man and the automaton in a space flight, we have examined the leg of orbital flight, maneuvering, the rendezvous and docking. We have not mentioned only the leg of placing into orbit. Here control over the engines of the carrier rocket on the injection leg and the stabilizing of the entire rocket-space complex has been done only automatically since with the significant shortage of time on this leg it would be hard for man to take the proper decision.

Thus, it can be concluded that in all stages of a space flight, the control functions are distributed between man and the automaton depending upon the nature of the task to be executed, the capabilities of man and the automaton and the advisability of automating one or another process. As a whole, the spacecraft control system is designed for optimizing automatic, semi-automatic, combined and manual control modes.

At the present stage in the development of cosmonautics, it is advisable, of course, to achieve the maximum utilization of the automatic control mode maintaining the other operating modes of the "crew--spacecraft" system as emergency ones and in the general instance to achieve an optimum combination of the capabilities of man and the automaton.

The Flight Control Center and Manned Space Flight

In carrying out the spaceflight program, when optimum use is made of the various operating modes of the "crew--spacecraft" system, a major role is played by the flight control center (FCC). It organizes the work of the crew and inflight systems of the ship (ZEMLYA I VSELENNAYA, 1979, No 5, p 12; 1983, No 5, p 9; No 6, p 18.--Editors). The FCC autonomously, without the involvement of the crew or together with it, can feed the necessary initial data into the onboard automatic equipment for the functioning of this equipment (the so-called "settings"), it can actively control the work of the crew and onboard systems, it monitors the necessary flight parameters, it plans the flight program and so forth. As a result, we have a more complex "crew--spacecraft--FCC" system in which its component element the FCC significantly increases the stable work of the "crew--spacecraft" link, it optimizes the system and provides the necessary crew safety. The carrying out of an extensive space program and the achieving of high results in the space research are simply inconceivable without the active work of the FCC. For example, let us examine the docking of a Soyuz spacecraft with an orbital station and which is essential to extended space

flights. Before executing this crucial, dynamic operation, the FCC selects the optimum mode for the rendezvous of the space devices, it feeds the initial conditions into the computer of the transport craft, it informs the crew of the spacecraft of these and gives the crew additional information on the particular features of the execution of the rendezvous conditions. Having obtained the entire range of information, the crew at the designated time and together with the onboard documents and ground instructions begins to carry out the rendezvous. In an analogous manner the FCC prepares the onboard systems of the orbital station for this, and if the crew is already on it, transmits the essential information to the crew. In the process of the rendezvous, the FCC can make an adjustment, feeding the necessary data into the onboard automatic equipment, or transmit to the crew new "settings" for controlling the onboard systems. In this manner the FCC not only determines the work of the onboard automatic equipment but also helps the crew utilize the various working modes of the "crew--spacecraft" system.

Thus, for more fully studying the work of man in space, it is essential to examine the basic elements of the "crew--spacecraft--FCC" system and take these into account in planning and implementing the space flights as well as in the training of cosmonauts.

10272
CSO: 1866/146

LYAKHOV AND ALEKSANDROV ON 150-DAY FLIGHT

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 84 pp 5-11

[Article by V. A. Lyakhov, USSR pilot-cosmonaut, twice HSU, and A. P. Aleksandrov, USSR pilot-cosmonaut, HSU]

[Text] During the second expedition aboard the "Salyut-7" station the cosmonauts V. A. Lyakhov and A. P. Aleksandrov carried out more than 300 experiments. These were experiments in the fields of astronomy, geophysics, medicine, bioengineering and biology, as well as visual observations for the purpose of studying the earth's natural resources. As always, during the flight technical experiments were carried out.

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Flight Objectives

Externally the "Salyut-7" station was similar to its predecessor, the "Salyut-6," but many of its systems were considerably reworked. The improvement of its systems was directed to an increase in reliability, a broadening of the automation of control and the scientific research program, as well as provision of more comfortable conditions for the crew. But more than improvement was involved. The station was developed as a multipurpose orbital object and the possibilities which it afforded were exploited in the course of implementation of the work programs by two expeditions. The new station also differs from its predecessors in that it is already not only a scientific research vehicle, but also a production base in space orbit.

The work of the first 211-day expedition aboard the "Salyut-7," consisting of A. N. Berezovoy and V. V. Lebedev (13 May-10 December 1982), a record in its duration, indicated that there are reserves for increasing the duration of flights and the number of their participants, and this is important for the further planning of space research.

The objective of our expedition was not to prolong the time of man's presence in space. The objectives were of a more technical nature, in particular, provision was made for an enhancement of the energy resources of the station by a build-up of the solar cells. And the implementation of such work involved emergence into space. Accordingly, one of the main tasks in preparing the expedition was ensuring emergence and the implementation of different kinds of assembly operations in open space.

Thus, the goal of our program took into account the interests of further development and improvement of space technology. And, to be sure, provision was made for a considerable volume of work in the interests of the fundamental sciences and different branches of the national economy.

The organization and technical support of the work of our expedition differed from the flight of A. N. Berezovoy and V. V. Lebedev. In particular, the satellite ship "Cosmos-1443" considerably expanded the field of activity of the crew when implementing the experiments. The engines of this satellite-ship repeatedly rotated the entire complex and for a long time held it with great accuracy in a position convenient for the implementation of geophysical, technical and astrophysical observations. The "Cosmos-1443" was many times used as a "tug" in correcting the station's orbit. For example, at the very onset of the work, already at the time of our flight on the ship "Soyuz T-9," using the "Cosmos-1443" the station was not only put into an orbit necessary for docking, but was held in a position convenient for the docking of our ship. The "Cosmos-1443" carried into orbit different kinds of equipment, expendable materials and additional sections of solar cells intended for assembly in space (in docked form the "Salyut-7" - "Soyuz T-9" - "Cosmos-1443" complex had a length of 35 m and a mass of 47 tons).

Space Experiments

Aboard the "Salyut-7" a study was made of the process of the direct effect of open space on different construction materials. In contrast to earlier experiments, when the samples were already studied on the earth, here the primary processing of material transpired aboard the station. First the investigated samples of composition materials were exposed for different times in open space and then were returned within the station. There, with the special "Electrotopograph" instrument, employing a nondestructive electrotopographic method, a study was made of changes in the surface state of the samples. The photographic films on which the results of this experiment were imprinted were delivered to the earth by the "Cosmos-1443" returnable vehicle. Then we made observations by a somewhat modified method. We hope that these investigations will assist the developers of space equipment in the choice of different kinds of materials.

In the technological experiments carried out during the course of our flight use was made of the improved "Pion-M" apparatus and the KGA-2 holographic apparatus. On the preceding flights the "Kristall," "Splav" and "Korund" apparatuses were used. They were used in producing crystals of different semiconductors in closed ampules, but it was impossible to peek into the ampule itself and to see how the crystallization process transpires under weightlessness conditions. However, in the instruments which we used during the second expedition the process transpired in transparent cells and was constantly recorded both on motion picture film and by the holographic method.

In addition to the photographic films and holograms which showed the processes transpiring during heating in liquid media, we sent back to earth crystals produced by a method widely employed in technology on the earth: the pulling of a crystal from a melt through a shaper. Now that we have carried out this work

specialists are inclined to regard the method as promising for producing unique semiconductors in circumterrestrial orbit.

During the time of the flight we continued experiments under the general name "Tavriya." The essence of these experiments was obtaining especially pure biologically active substances by the electrophoresis method. These experiments were initiated on the "Salyut-7" by the crew consisting of L. I. Popov, A. A. Serebrov and S. Ye. Savitskaya. Then only materials from photoregistry of the process were returned to the earth. Later A. N. Berezovoy and V. V. Lebedev continued the research and returned with the components of the matter separated in space. In the course of the "Tavriya" program carried out earlier it was possible to solve a number of technical problems not encountered earlier in Soviet practice. A new design of an electrophoretic apparatus, unique in the field of purification of biological substances by the electrophoresis method, was developed.

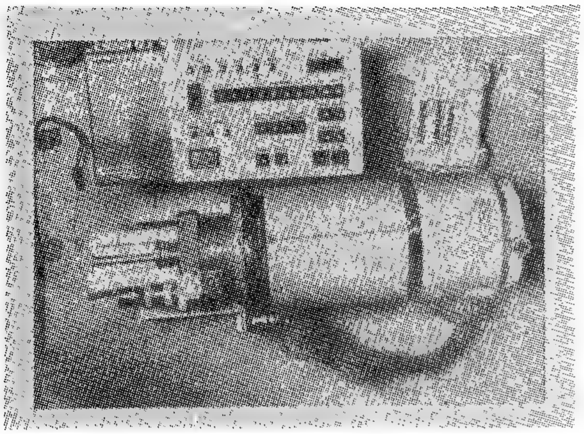
Our crew continued work under this interesting program. We obtained eight ampules of especially pure antiviral preparations -- antigens of the flu virus. It is particularly pleasant to note that this work was carried out at the request of one of the leading institutes of the country in the field of epidemiology -- the Epidemiology, Microbiology and Hygiene Scientific Research Insitute imeni Pasteur, ensuring its annual requirements for such preparations for carrying out experimental work. Thus, the systematic in-orbit production of particularly pure substances for the needs of medical science and practice began.

The need for such substances is now particularly acute. It is known that due to impurities causing different allergic reactions such antiflu serums are not administered to children and their dose for adults is also limited. Unfortunately, under terrestrial conditions it is impossible to create preparations of the necessary purity; the purity of the substances produced in orbit exceeds that produced on the earth by a factor of approximately 10-15. Moreover, the productivity of the electrophoretic apparatus working in a state of weightlessness is several hundred times greater than on the earth. In flight we continued the "Gel'" experiment, also related to the practical tasks of obtaining particularly pure biological substances in space orbit.

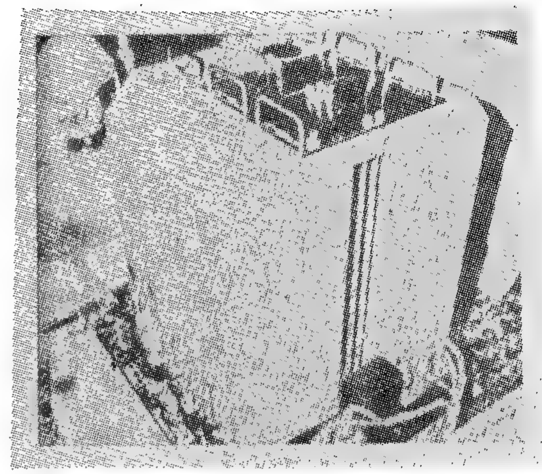
We also carried out biological research. A. N. Berezovoy and V. V. Lebedev for the first time in orbit cultivated the seeds of higher plants which were viable. The researchers were faced with new problems related to the perfecting of the technology of cultivation of plants aboard a space station. We carried out full assembly of the "Oazis" biological apparatus with the use of the electric stimulation of plants, the effect of electrochemical potential on them. It can be hoped that sometime such apparatus will not only be assembled in orbit, but also that the cosmonauts will use the plants cultivated in it as food.

In accordance with the program of geophysical experimentation we took photographs of the earth's surface. The MKF-6M and KATE-140 stationary cameras were used in taking more than 20,000 photographs. These photographs covered about 300 million square kilometers of the land and world ocean.

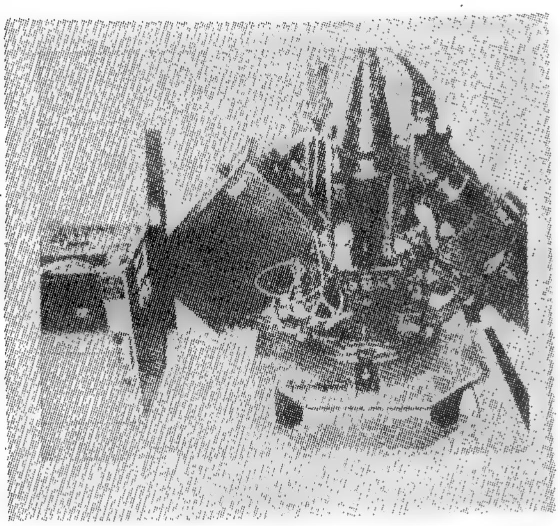
Training of crew aboard the teaching-training mock-up of the "Salyut-7." V. A. Lyakhov and A. P. Aleksandrov are working with scientific equipment.



General view of "Kristall" technological apparatus.



MKF-6M multichannel camera for survey of earth's surface in different spectral ranges.



MKS-M spectrometer developed by GDR specialists. This instrument provides spectral information for a more detailed interpretation of photographs of the earth's surface.

A. P. Aleksandrov, in open space, assembles additional sections of solar cells.

The geophysical research was carried out under a multisided program. An example is the "Chernoye More" (Black Sea) experiment. In this case the photographic and spectral apparatus was used at different altitudes. We made such a survey from space. The scientists of East Germany (GDR), Mongolia, Poland, Bulgaria, Romania and the USSR worked synchronously with us in an aircraft and on ships with the same instrumentation. The objective of the experiment was the perfection of a method for investigating the ocean from space, during which interesting experience was accumulated in the use of the MKS-M spectrometer, developed

by GDR specialists. The instrument has two blocks. One is used in studying the ocean, whereas the other is intended for investigation of the atmosphere, which, as is well known, is the main source of interference in geophysical experiments in orbit. A comparison of data will make it possible to eliminate this interference.

During prolonged flights a special place is occupied by visual observations of the earth's surface; we made them with great interest. On the basis of visual observations we transmitted about 20 communications to geologists, oceanologists, meteorologists and agricultural specialists. Under the UNESCO program "Man and the Biosphere" observations were made not only of biological preserves in the territory of our country, but also the national preserves of South America, Africa and Australia.

The "Yelena" gamma telescope, employed for the first time on the "Salyut-6," was used in carrying out astrophysical experiments. On our flight the most interesting fact was the discovery of fluxes of high-energy electrons in the the earth's inner radiation belt, the spurs of which the station orbit intersects in the region of the Brazilian anomaly. We were to collect material for a detailed investigation of the fluxes of these earlier discovered particles. The gamma telescope operated a total of more than 300 hours. The second objective in work with the "Yelena" gamma telescope was a study of the conditions which the developers of future high-transmission gamma telescopes must know.

Assembly Work in Open Space

The work in open space became the most important with respect to scientific and practical results and the most outstanding in its emotional content. This work involved the installation of additional solar cells. On 1 and 3 November 1983 the crew emerged twice into space from the station; the total duration of the stay in open space was 5 hours 45 minutes. Assembly work with additional sections of solar cells increased the power of the station electric supply system and at the same time confirmed the good prospects for the developed technology for the assembly of large-size structural parts under space conditions, the correctness of the design decisions and the methods for conducting the work. The additional panels which we installed on the two sides of the main solar cell increased its power by a factor of 1.5.

Such work was carried out in space for the first time. Therefore, already on earth each operation was carefully worked out to perfection and training sessions were carried out at a real time scale in a hydrobasin. Training sessions in a hydrobasin under conditions of simulated weightlessness with respect to the nature of the performed operations are most similar to work conditions in space. Training operations were practiced with full-size mock-ups, the cosmonauts being clad in spacesuits. The time indices and the physical energy expenditures are of the same order of magnitude as in space.

When we assembled the solar cells in space, synchronously with us similar work was performed in the hydrolaboratory by the group of test pilots who trained us. In the event of difficulties the duplicating team on the ground could give

us assistance with their recommendations. Specialists planned the work in such a way that the principal, most fundamental operations were carried out in zones of radiovisibility in the light part of the orbit, maintaining direct communication with the group working in the hydrolaboratory.

The build-up of the solar cells is affording real possibilities for different kinds of installation and assembly work in space. We will strive to transmit the experience which we have acquired to those who must work in open space, but it is necessary, it goes without saying, to introduce definite corrections into the course of training and the work method.

In the course of the flight the crew executed experiments and research, corrected the orbit of this complex, test-checked the ship orientation regimes and other dynamic operations. In addition, we carried out necessary operations for ensuring docking and undocking with the transport freighters.

The great duration of the flight also required from us the implementation of a series of preventive measures during preparations for and return to the earth. This series of measures, experience from the preceding prolonged flights and the medical apparatus carried on the station, all this enabled us and the specialists on earth to monitor and evaluate the state of our health quite completely and in the course of the entire flight maintain performance at a good level. The crew carried out more than a hundred medical investigations and experiments.

A physical load was apportioned in each stage, depending on the tasks which the crew performed during this period. It was increased by the end of the flight. Our work and rest regime was organized on the basis of a 5-day work week with two days of rest. The psychological mood in the crew was favorable; this was favored by weekly meetings with families, friends and popular artists in communication sessions. The psychological support group organized such measures for us.

A great deal was done during the 150 days of work in space and we hope that the results of this work will find application in many fields of science and the national economy and will serve as a basis for further improvement of space technology and methods for its use.

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CSO: 1866/178

COMMENTS ON 'SALYUT-7' 150-DAY FLIGHT

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 84 pp 10-16

[Article by K. P. Feoktistov, doctor of technical sciences, and A. A. Longov]

[Text] The "Salyut-7" station differs from the first generation of the "Salyut" ship in that it has a second docking unit making it possible to supply the station with everything necessary for vital functions; it has a combined engine, designed for multiple refueling and the prolonged storage of fuel; comfort was considerably improved. The implementation of the program by the second long-term expedition aboard the "Salyut-7" station was particularly interesting from the engineering point of view.

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Reasons for Flight Into Space

The question frequently arises: today is there any need for man's prolonged presence in space? After all, the construction of automatic vehicles is less expensive than the construction and operation of large orbital complexes. One could cite a great many arguments both in support of automatic vehicles and in support of long-lived manned complexes (ZEMLYA I VSELENNAYA, No 2, p 19, 1984 -- Editor's note). And yet it is impossible to get by with automatic vehicles alone for the effective solution of research problems. Long-lived orbital space flights are necessary. Man has unique possibilities: as before he is irrelaceable when it is necessary to analyze rapidly changing situations, to make unordinary decisions, to change conditions for the implementation of experiments, to regulate equipment, to intervene routinely in transpiring processes, and finally, to carry out repair and preventive maintenance work with station systems.

All the problems to be solved aboard an orbital complex can arbitrarily be broken down into four groups.

The first group, the largest and most diversified, takes in numerous investigations, experiments and tests of scientific equipment. Within the framework of this group studies are made of phenomena at the earth's surface, in the earth's atmosphere, in near and distant space, and also processes within living organisms.

The second group of problems includes elements of industrial production, that is, the fabrication, although for the time being in small quantities, of crystals and different alloys, as well as medicinal preparations. This includes observations of the earth's surface at the request of different branches of the national economy, which due to this work even today is profiting by considerable savings.

The third group should include study of the human body under spaceflight conditions, determination of the admissible duration of presence of the living organism under weightlessness conditions and the optimum duration of man's work in space with maintenance of high performance, as well as a more precise determination of the optimum conditions for work and rest of the crew, analysis of the psychological factors arising during prolonged flights in the limited space of the station, and other biomedical problems.

The fourth group includes problems related to the improvement of space technology, the broadening of the range of problems to be solved with manned space vehicles by a change in the initial design, as well as restoration of the operability of station units and assemblies.

Man in State of Weightlessness

The second long-term expedition on the orbital station "Salyut-7," launched on 19 April 1982, ended on 23 November 1983. The flight program provided for work relating to all four enumerated groups.

The preceding expedition (A. N. Berezovoy and V. V. Lebedev) was a record in duration; the cosmonauts spent 211 days on the "Salyut-7" station (ZEMLYA I VSELENNAYA, No 5, p 9, 1983; No 6, p 18, 1983 -- Editor's note). During all this time the physicians studied the effect of space factors on the human body: changes in human blood and bone tissue, the influence of weightlessness on vision and hearing. For the time being it is impossible to mention with assurance all the factors which are responsible for these temporary body changes. However, relying on the experience of preceding expeditions, physicians and engineers have achieved considerable successes in decreasing the unpleasant consequences of weightlessness during the time of flight.

The crew of the second expedition on the "Salyut-7" station -- V. A. Lyakhov and A. P. Aleksandrov -- were faced with a different task. The engineers and physicians wanted to find the "perfect balance" when the crew was loaded to the maximum with work in the course of the workday and at the same time could maintain a high performance during the course of the entire flight. They wanted to understand what cycle of work and rest was preferable: a full week, or possibly a regime in which three days of work are followed by a day of rest. How many days of rest should there be each week -- two? Or is one adequate? Was it desirable to shift "sleep-wakefulness" cycles in the course of 24-hour periods? For the crew of the second expedition the plans called also for "night" work and work with an increased working zone in the course of a 24-hour period, as well as a series of responsible operations with a high emotional load; plans called for working zones with frequent switchings from one type of activity to another and working zones when the crew was occupied by

work alone (for example, emergence into open space). And all this time observations were to be made of the state of the crew.

V. A. Lyakhov and A. P. Aleksandrov successfully coped with the assigned tasks. The results of the completed flight are making it possible to evaluate the merits and shortcomings of the selected work and rest regime, to use the experience of the cosmonauts when drawing up programs for new expeditions. The results are also making it possible to determine more precisely the duration of a flight and the workload of the crew so that it can maintain a high performance.

As is well known, prior to the second expedition on the "Salyut-7" station the heavy freighter-satellite "Cosmos-1443" was automatically docked to it on 10 March 1983. In this way three fundamental problems were solved: delivery of about 2,800 kg of freight to the station was accomplished (renewable elements of the life support system, scientific equipment, equipment for preventive maintenance and repair of the station, etc.); return to the earth of the results of experiments and investigations, as well as scientific instruments subject to investigation on the earth; performance of maneuvers in orbit, making possible a new orientation of the complex in order to carry out different experiments.

In principle all this can be accomplished by means of transport ships of the "Soyuz" and "Progress" types. But their possibilities, to be sure, are less. In fact, among other things, the "Cosmos-1443" satellite-ship was used both as a special "tug-module" and an "engine-module." Having 3,000 kg of fuel in its tanks, for a long time it assumed the functions of an engine and the control system for the orbital complex. If we digress from the considered expedition and fantasize a little, we can visualize that in the not distant future such modules will come to perform not only the functions of an engine or control system, but also the functions of a power supply system and life support system. There will be "factory modules" and "research modules."

The range of use of the "Progress" freighter was broadened. It was used for test-checking of a system for refueling the combined engine and approach system; it was used as an object for experiments. Here it is important that the "Progress" vehicles arrive at the station regularly, each time making it possible to supply them with new necessary equipment.

Another interesting type of work, affording possibilities for the development of orbital complexes, was the installation of additional solar cells. In itself the renewal problem, and in case of necessity, an increase in the efficiency of solar cells, is attractive from the engineering point of view. It is known that under the influence of ultraviolet radiation and meteor streams the solar cells gradually lose their qualities. Designers are faced with the task: either to compensate for the loss of efficiency of the solar cells, consciously increasing (above the necessary value) their initially rated area, in order that they function faultlessly as long as the space vehicle is in operation, or, as necessity arises, deliver and build up the panels of solar cells, thereby maintaining the required power in the on-board power supply system. The second variant was selected for the "Salyut-7" station.

How were the additional solar cells installed on the "Salyut-7" station? Three stages can be defined. First they were prepared for transport and installation on one of the panels of solar cells. The orbital complex was oriented in such a way that the workplace of the cosmonaut-assembler on the body of the station was illuminated and the panel on which the additional solar cell was to be placed was fixed in position. Then the crew carried the cell to the place of installation along specially installed railings on the outer side of the station's body.

The second stage included the installation of an additional solar cell in the intended place, its freeing from the transport container and mechanical and electric connection with the main panel of solar cells. Then it was deployed by A. P. Aleksandrov using a winch.

In the final, third stage the additional solar cell was connected to the system for the integrated electric supply within the station.

Such a simplified description can give the impression that a build-up of panels of solar cells is an extremely simple matter. But it must be remembered that this work was done for the first time in open space, in spacesuits. But it was preceded by heated disputes and a discussion of different variants of execution of this task; the design of the additional solar cells and the mechanisms for their installation and deployment were checked out on the ground, accompanied by the training of crews in a hydrobasin and in aircraft laboratories.

As a result it was possible to acquire the first valuable experience in assembly-installation work in open space, to confirm the unique capabilities of man and to check engineering decisions.

Still another direction in man's activity in orbit, assembly-installation work, was defined. This direction is characterized by careful ground preparation of the construction components and tools and the acquisition of work experience with them while still on the earth. For the time being work with tools had been performed only within the station, and this for the most part metal work. Now, however, after learning to manipulate all kinds of tools while in spacesuits and after acquiring experience with assembly-installation work in open space, there can be a substantial change in the orbital complexes: in-flight deployment of structures, change of their elements and repair of space vehicles. In other words, work on the build-up of the solar cells opened the way for a more intensive operation of manned orbital complexes.

Results of Orbital Flights Into Practice

On orbital stations of the "Salyut" type from the first flight great attention was devoted to investigations of the earth's natural resources, checking of research methods, choice of the necessary makeup of the instrumentation and planned study of different sectors of the earth's surface and ocean. Such observations take in great regions of the earth and are carried out over a long period of time. They yield information on the state of the earth's surface and the oceans, the types of harvest, contamination of water basins, concentrations of plankton in the ocean and forest fires, and nevertheless

for the time being it is impossible to say that everything is already done, that we just look at and interpret the data collected by the developed methods... There are still many difficulties. Intensive research is being carried out on the optimum parts of the observation spectrum, methods for the accumulation of information aboard and its routine transmission to the earth. New principles are being formulated for investigating the earth's surface and the ocean.

The cosmonauts V. A. Lyakhov and A. P. Aleksandrov tested a new instrument for these purposes, the "Tsvet-1" colorimeter. The instrument was switched on simultaneously with the photographic and spectrometric apparatus. It made it possible to obtain calibration data on the color characteristics of the observed sectors, by means of which it will be possible with great reliability to process the photographic materials transmitted from orbit. Naturally, in this case it is necessary to have information obtained directly from the place of the observations, such as information characterizing the growth of plants, state of the soil, state of agricultural crops and depth of the snow cover.

The crew of the second expedition made observations of many regions of the Soviet Union: southern regions of the Ukraine, Krasnodar Kray, Caucasus, Northern Caspian, Central Asia, Gornyy Altay and Far East. Within the framework of the "Intercosmos" program a study was made of some regions of Bulgaria, Hungary, East Germany, Cuba, Mongolia, Poland, Romania and Czechoslovakia.

The crew is daily allocated time for investigations of natural resources. The cosmonauts make use of different kinds of spectrometric instrumentation, including the MKF-6M camera (for a multizonal survey), developed jointly by specialists of the USSR and East Germany and fabricated in East Germany (ZEMLYA I VSELENNAYA, No 1, p 74, 1981 -- Editor's note). Simultaneous measurements in a wide range of wavelengths make it possible to evaluate the state of the ocean and to detect regions polluted with petroleum. On images in the IR range it is easy to distinguish the boundaries of warm and cold regions in the ocean and see oceanic eddies and regions covered by ice. On the basis of the modified color of the water it is possible to detect concentrations of very tiny algae (phytoplankton). The information emanating from space immediately finds practical use.

The multipurpose "Black Sea" experiment was carried out in the course of the second expedition. Participating together with Soviet specialists were scientists of East Germany, Bulgaria, Mongolia, Poland and Romania. The studies were made simultaneously from space ("Salyut-7"-"Soyuz" orbital complex and "Meteor" automatic satellite), from an aircraft-laboratory and at the sea surface and with instruments lowered under the water from ships. Such broad research accelerates solution of the problem of the effect of the ocean on the atmosphere and make it possible to comprehend the processes of formation of weather and climate.

At the request of the Epidemiology, Microbiology and Hygiene Scientific Research Institute imeni Pasteur, V. A. Lyakhov and A. P. Aleksandrov carried out investigations with the "Tavriya" apparatus. They obtained 8 ampules of particularly pure preparations of antigens of the flu virus. The employed

equipment makes it possible, using the state of weightlessness, to divide the initial biomass into fractions and to obtain superpure preparations not causing side effects. Great difficulties are involved in obtaining such preparations under terrestrial conditions.

Space Laboratory

It is difficult to draw a boundary between where a space experiment ends and the practical use of the results of research begin. After the manned flights of the "Salyut" station many new fields of research began. Already there is talk of the founding of new branches of science: space oceanology, space astronomy and the physics of weightlessness.

In the course of several expeditions on the "Salyut-6" and "Salyut-7" stations experiments were carried out with holographic apparatus developed at the Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences. The developers succeeded in constructing a rather compact apparatus without the traditional flat placement of the parts of the holographic apparatus. They are placed three-dimensionally in a container which is resistant to vibrations. A special feature of the developed holographic apparatus is its universality. The apparatus was also used on the "Salyut-6" station. Then the first holographic space photographs were obtained and methods were developed for the transmission of information to the earth for the use of specialists (in this number of the journal see page 17 -- Editor's note). On the "Salyut-7" station, at the time of the first expedition, A. N. Berezovoy and V. V. Lebedev used the holographic apparatus in the course of the "Tavriya" experiment. During the second expedition V. A. Lyakhov and A. P. Aleksandrov, using this same apparatus, obtained a holographic interferogram of heat and mass transfer in a liquid medium under weightlessness conditions. At the same time, by the shadow survey method, it was possible to register the process on a motion picture film. The experiment was carried out with the "Pion M" apparatus. This same apparatus was used in studying processes of capillary shaping during the cultivation of crystals under conditions of microaccelerations and two-dimensional convective currents of fluid were investigated.

Aboard the "Salyut-6" and "Salyut-7" stations the cosmonauts regularly carried out investigation of meteor erosion and contamination of surfaces. The clouds of particles which surround the manned station can be precipitated on the radiation surfaces, on the optical elements of the instruments and on elements of the solar cells. These particles are formed during operation of the engines, the discarding of wastes of vital functions through the lock and due to the degassing of materials on the station surface. The collected particles are then analyzed on the earth, to which samples of glass, plastics, coatings and other materials are returned. Emerging into open space, the cosmonauts regularly replace the samples.

The possibility of an encounter with meteorites is by no means small. During the years of flight of the "Salyut-6" station its windows more than once were subjected to the influence of micrometeorites which left appreciable "craters" on the outer side of the glasses. One such "crater" with a diameter of 3 mm (due to collision with a micrometeorite) was discovered on the docking unit of the station. Precisely the assurance of safety during an encounter with

micrometeorites is one of the factors exerting an influence on computation of the thickness of the pressurized envelope of the station and its external shields.

During the time of the second expedition the "Elektrotopograf" apparatus was used in a study of the influence of open space on different materials. After these samples were exposed in space through the lock, the cosmonauts investigated them by the method of nondestructive electrotopographic scanning.

Using the test gamma-telescope, the cosmonauts measured the fluxes of high-energy electrons, secondary fluxes of gamma quanta arising in the compartments of the orbital station during the interaction of primary cosmic rays with the matter of the station. An experiment was carried out for studying the spatial distribution of absorbed radiation doses in a spherical phantom simulating the human body.

Several hundred experiments were carried out by V. A. Lyakhov and A. P. Aleksanandrov during the 150-day flight. The collected information is being carefully processed by specialists and new experiments in space are being planned. The flight of the second long-term expedition has already become history. The flight of the "Salyut-7" station is continuing.

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PLANS FOR 'INTERBOL' SATELLITE EXPERIMENT

Moscow MOSKOVSKIY KOMSOMOLETS in Russian 7 Oct 84 p 4

[Article by Yu. Gordeyev]

[Abstract] The article provides information on directions and objectives of studies of sun-Earth ties which socialist-bloc and western countries have been pursuing jointly with the aid of spacecraft.

Particular attention is devoted to studies which are planned in a project called "Interbol" under the "Intercosmos" program. Scientists of Bulgaria, Hungary, the German Democratic Republic, Cuba, Poland, Romania, the USSR, Czechoslovakia, France and Sweden reportedly are taking part in this project. It is noted that similar projects are planned by western space-research organizations. In the "Interbol" project, measurements are to be made simultaneously in various regions of near-Earth space, and the condition of the solar wind and the magnetosphere is to be monitored. This is expected to shed light on cause-and-effect relationships among a number of processes which are little understood as yet. These studies will be conducted with the aid of a complex consisting of a satellite of the "Prognoz" series and a subsatellite of the "Magion" type, which will fly at a certain distance from the "Prognoz". Plans call for the launching of two such complexes, one of which will be placed into the tail of the magnetosphere, where magnetic-field energy accumulates and plasma processes take place which convert this energy into electric energy. The second complex will simultaneously conduct measurements in three regions of the magnetosphere where plasma processes occur which give rise to polar auroras in the atmosphere and magnetic disturbances on Earth.

As compared with the western projects, the spacecraft to be used in the "Interbol" project possess a number of advantages which will substantially heighten the quality of information obtained, particularly in studies of active magnetosphere processes of short duration, according to Doctor of Physical-Mathematical Sciences Al'bert Galeyev, scientific director of the project. In particular, the use of subsatellites in measurements will make it possible to nullify errors of systems. Onboard computers will control the sequence of telemetry readings from a wide range of instruments.

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RADIO TELESCOPE USED FOR SOLAR OBSERVATIONS

Moscow KOMSOMOL'SKAYA PRAVDA in Russian 12 Dec 84 p 4

[Text] Scientists of the Siberian Institute of Earth Magnetism, the Ionosphere and the Propagation of Radio Waves are observing the sun with the aid of a new and highly sophisticated radio telescope in the Tunkin Valley in the foothills of the Sayan Mountains. This telescope's 256 spherical radio antennas form a single system -- a kind of mirror that is 622 meters in diameter. This intricate astrophysical complex is controlled by computers.

(The photograph shows a portion of the telescope's antennas.)

FTD/SNAP
CSO: 1866/55

RADIO TELESCOPE BEING BUILT IN ARMENIA

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Dec 84 p 4

[Text] A powerful radio telescope is being built at an elevation of 2,000 meters above sea level, at the All-Union Scientific Research Institute of Radiophysical Measurements in Armenia. It is intended for studies of distant galaxies, non-stationary objects and planets.

(The photograph shows a portion of the radio telescope.)

FTD/SNAP
CSO: 1866/55

ALL-UNION CONFERENCE OF RADIO ASTRONOMERS

Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 84 pp 61-64

[Article by V. M. Kontorovich, doctor of physical and mathematical sciences]

[Text] The 15th All-Union Conference on Galactic and Extragalactic Radioastronomy was held in Khar'kov in October 1983. More than 200 persons participated, of which 150 were guests from the leading radioastronomical observatories and institutes of the country. A total of 74 reports were presented at the plenary sessions (including 14 review reports) and 98 reports were represented at exhibits.

Now, 50 years after the pioneering investigations of K. Yanskiy, a study of the universe, especially its evolution, is no longer thinkable without radioastronomy. The radio sky differs substantially from the ordinary star sky primarily in that one can see clearly not the stars, but objects of a completely different type. Among these are radio galaxies and quasars, for most of which the radio emission arrives from two gigantic clouds, in size considerably exceeding the "parent" galaxy visible in the optical range. The clouds are situated symmetrically on both sides of the galaxy at distances up to hundreds of kiloparsec from its center. Nevertheless, the energy source in all probability is situated at the nucleus of the galaxy from whence jets "visible" for the most part in the radio range extend to the radio clouds. Until now no one has comprehended either the mechanisms of activity of the nuclei, nor the nature of the jets, nor the method of transformation of jet energy into the radio emission of the clouds. Therefore, a report by N. S. Kardashev on investigations of the nucleus of our Galaxy and on a model which from a unified point of view explains its activity in the radio, X-ray and gamma ranges was of very great interest. This model assumes the presence of a massive compact object (possibly double -- in the most exotic variant containing a black hole) at the center of the Galaxy. It has a powerful magnetic field and rapidly rotates, generating electric fields. This is seemingly an analogue of a massive pulsar, accelerating a beam of electrons and positrons directed across the plane of the Galaxy and in turn generating a beam of gamma quanta. We observe only a very small part of the energy released in this process. Thus, our galactic nucleus may not be as calm as it seems.

A review of the active nuclei of other galaxies was given by B. V. Komberg. To one degree or another activity is manifested by the nuclei of most galaxies.

In the most active, usually more massive nuclei, matter is concentrated more strongly toward the galactic center (there are many objects of the spherical component) and an increased content of gas and dust. The formation of an active nucleus is favored by the crowding of the galaxies and interaction among them, sometimes even leading to "cannibalism." R. D. Dagkesamanskiy told about the properties of the radiogalaxies entering into the cluster, to which all the brightest radiogalaxies belong.

The results of interferometer observations of radiogalaxies at the longest (decameter) radio waves were given in a report by A. V. Men'. Using the URAN-1 interferometer (base 42.2 km) it was possible to detect compact radiosources in the cluster of galaxies in the constellation Perseus, as well as in residues of flares of supernovae -- Cassiopeia A and Crab nebula, which agrees with measurements by the scintillation method using the UTR-2 decameter radiotelescope, Ukrainian Academy of Sciences. Considerable interest was shown in observation of a compact detail in Cassiopeia A, which was discussed by V. P. Bovkun. We recall that no pulsar has been discovered in this youngest "historical" remnant of a supernova explosion.

T. A. Lozinskaya presented a review report devoted to modern data on the remnants of supernovae. These objects are some of the brightest in the radio sky. Among the 150 radio-emitting remnants of supernovae about 40 are visible in the optical and about 50 in the X-ray range. Star remnants of an explosion (neutron stars) have been discovered in only a few in the form of pulsars. Earlier it was surmised that pulsars were simply "not seen" due to unsuccessful orientation of the radio ray, but X-ray observations indicate that in actuality there are no neutron stars in most of the remnants, having a cloud structure. The latter arise during the explosion of stars with a small mass -- type-I supernovae. After the explosion of massive stars -- type II supernovae -- pulsars are formed which send accelerated particles into the nebula surrounding it and generate a magnetic field in it. As a result, another type of remnant, pleurions, forms. For a long time these have a three-dimensional, not a cloudlike structure (as, for example, the well-known Crab nebula). In such a nebula the brightness increases toward the center. The radio emission of a supernova does not arise immediately, but several months after an explosion. A report by V. N. Fedorenko was devoted to the possible reasons for this.

At the conference much attention was devoted to pulsars. In a review report A. D. Kuz'min and V. S. Beskin discussed the discovery of the first extragalactic pulsar (PSR 0512-66) in the Large Magellanic Cloud; short-period pulsars were discovered: PSR 1937+21 with a pulsation period of about 1.5 msec (ZEMLYA I VSELENNAYA, No 2, p 12, 1983 -- Editor's Note) and PSR 1953+29 with a period of about 6 msec, the latter a part of a binary system. The accuracy of the period of these pulsars is approximately 1 μsec, which corresponds to the accuracy of atomic time standards. Four pulsars have already been discovered in binary systems, as a result of which it was possible to estimate the mass of the neutron stars (about 1.4 the solar mass), the density of plasma within the stellar magnetosphere (about 10^{-3} particle per 1 cm^3) and most importantly, to carry out with an accuracy which was previously impossible an experimental checking of the general theory of relativity, predicting, in particular, gravitational radiation in binary systems. This radiation is determined from the

change in the orbital parameters of a binary system which can be measured precisely if there is a pulsar in the binary system.

Pulsars constitute a unique physical laboratory and their radio emission carries an enormous amount of information concerning the state of matter in strong fields. But it is not possible to interpret it completely due to the lack of a detailed theory of the radio emission of pulsars.

A review by Yu. M. Bruk was devoted to a detailed analysis of the interpulse emission (the appearance, in addition to the main pulses, of intermediate pulses as well) observed for the most part at decameter wavelengths. Decameter interpulses, discovered by Khar'kov radioastronomers using the UTR-2 at a frequency of 25 MHz (ZEMLYA I VSELENNAYA, No 5, p 24, 1981 -- Editor's note) were also observed with the antenna of the Physics Institute, USSR Academy of Sciences, at frequencies 60 and 30.6 MHz and by American radioastronomers in Florida at a frequency of 26.3 MHz. The nature of this phenomenon has not yet been discovered.

Recently the problems involved in star formation have become one of the most important applications of radioastronomy. Observation of radio emission lines (including maser lines) in dark opaque clouds makes it possible to obtain detailed information concerning the dynamics and structure of regions of star formation. This was covered in a review report by V. S. Strel'nitskiy and R. L. Sorochenko and in a number of other reports. Nevertheless, the fundamental concepts concerning the formation of stars from the interstellar medium still cannot be regarded as experimentally demonstrated and there is a need for detailed spectral investigations in the radio range.

The study of recombination lines of carbon carried out with the UTR-2 radiotelescope was discussed by A. A. Konovalenko. These lines, having a number of unusual properties, can be observed with transitions between energy levels with uniquely high "sequence" numbers (main quantum numbers) from n = 603 to n = 732 (!). Quite recently the radioastronomers of the Physics Institute, USSR Academy of Sciences and the State Astronomical Institute imeni P. K. Shternberg (SAI) discovered recombination radio emission lines at meter wavelengths (n = 538 and 486). The observation of such high-positioned transitions makes it possible to determine physical conditions in the cold absorbing regions of the interstellar medium.

A report by V. I. Slysh was devoted to the evolution of the chemical and isotopic composition of the interstellar medium.

Radioastronomical observations are of exceptional interest for cosmology. The expanding universe in the past, with a red shift of about 1,000 (all distances were 1,000 times less than today), passed through a stage when the cooling matter passed from an ionized state into a neutral state and was separated from radiation. From that time there has persisted the relict radiation filling the universe which has now cooled to a temperature of approximately 3 K. This radiation should retain information on inhomogeneities of matter existing with a red shift of 1000 and later giving rise to galaxies and their clusters (ZEMLYA I VSELENNAYA, No 6, p 35, 1982 -- Editor's note). Brightness fluctuations of

the relict background were investigated using the RATAN-600 radiotelescope of the Special Astrophysical Observatory, USSR Academy of Sciences. The results of these observations, included in the "Kholod" ("Cold") experimental program, were discussed by Yu. N. Pariyskiy. With an accuracy to 10^{-5} no microscale fluctuations of relict radiation were discovered, giving rise to a whole series of problems in the theories of origin of galaxies.

One of the alternatives was mentioned by N. S. Kardashev in the discussion which followed the report by Yu. N. Pariyskiy. With a red shift of 10 the universe could again become opaque as a result of secondary heating during the formation of massive stars. After the repeated heating of the universe only macroscale fluctuations of the relict background could persist. The search for such fluctuations began from aboard the "Prognoz-9" artificial satellite under the program of the "Relikt" ("Relict") experiment in which a highly sensitive weakly directional antenna was used.

One of the most important tasks in radioastronomy is the compilation of a detailed "radiomap" of the sky, as was discussed at the conference by representatives of teams carrying out radio scanning with the UTR-2 and RATAN-600 telescopes. In particular, M. G. Larionov reported that at a wavelength of 8 cm the radioastronomers of the State Astronomical Institute have discovered about 10,000 radio sources, a third of which are new.

Interesting reports were devoted to the famed object SS 433, in miniature reminescent of grandiose extragalactic objects (ZEMLYA I VSELENNAYA, No 4, p 20, 1980 -- Editor's note), polarization research carried out at meter wavelengths at the Gor'kiy Radiophysics Scientific Research Institute, microwave radiation of magnetic stars, annular structure of magnetic fields in the Galaxy and many other interesting and important questions.

The sections devoted to exhibits were particularly lively. The exhibits were set out in the hall in front of the auditorium at Khar'kov University in which the sessions were held. Taking into account that summaries of all the presented reports were printed prior to the beginning of the conference, this created favorable conditions for discussions. It was the opinion of the participants that this form of representation of reports was justified.

Observations constitute the basis of radioastronomy, as in any other field of astronomy. It was noted in a conference resolution that there is now an acute need for the development of a modern base for making observations in the radio range, especially in its short wavelength part. This would assist in successful solution of the problems facing radioastronomers.

5303
CSO: 1866/178

UDC 523.3+523.4

MODERN PROBLEMS IN POLARIMETRY OF SOLID SURFACES OF COSMIC BODIES

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 18, No 3, Jul-Sep 84
(manuscript received 12 Apr 84) pp 163-178

SHKURATOV, Yu. G., AKIMOV, L. A. and TISHKOVETS, V. P., Khar'kov
Astronomical Observatory

[Abstract] Optical polarimetry is one of the least developed methods among those which can be employed in remote study of cosmic bodies not having an atmosphere. Recently increased interest in this method has been displayed by planetologists specializing in study of the composition and structure of solid planetary surfaces. The authors therefore demand it timely to present this review of the most important aspects of polarimetric studies of such bodies. Different sections are devoted to the following subjects: negative polarization of light (P_{min}, α_{inv}, α_{min} parameters) and orientation of polarization plane; phase variation of negative polarization; correlation between negative polarization parameters and other optical characteristics; conditions for appearance of negative polarization (influence of surface structure); Umov effect applicable to cosmic bodies without atmosphere; positive polarization of light (parameters α_{max}, δ and h); circular polarization as promising direction in polarimetric study of cosmic bodies without atmosphere. Emphasis is on those subjects poorly covered in the literature. In some cases, it is stressed, the second Stokes parameter should be used instead of the traditional degree of polarization. Various models of negative polarization are subjected to a critical analysis and some new experimental facts are presented. Figures 3; references 39: 18 Russian, 21 Western.
[190-5303]

UDC 521.14

EXPANSION OF FUNCTIONS DESCRIBING PLANETARY SURFACE AND GRAVITY FIELD

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 18, No 3, Jul-Sep 84
(manuscript received 5 Mar 84) pp 208-214

VALEYEV, S. G., Kemerovo State University

[Abstract] The problem of description of the surface and gravity field of planets is examined using an expansion in spherical and other functions with particular consideration of the problem of expansion of lunar relief in spherical functions. The factors exerting an influence on approximating expressions can be divided into two groups. The first group includes errors generated by observational errors. This article stresses errors in the second group, generated by the mathematical description itself. The approach used in solving the problem is statistical (regression) modeling. The article applies this approach in expansion of a function describing averaged surface relief by a number of spherical harmonics. The numerical example presented shows that the use of regression modeling makes it possible to obtain expansions with a number of terms approximately half as great as in the ordinary approach with the same or a higher descriptive accuracy. There is a discussion of work done on choosing an effective procedure for finding an optimum model. Also examined are the problems caused by the great dimensionality of the problems and the diversity of variants of initial data. The described approach gives adequate but economical models of relief and the gravity field. At present these models contain an excess number of terms not having information value which make difficult and encumber description of physical phenomena. Tables 2; references: 15 Russian.
[190-5303]

UDC 523.24:521.1/3

AVERAGING OF EQUATIONS OF COMETARY ORBITAL MOTION WITH ALLOWANCE FOR NONGRAVITATIONAL EFFECTS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 18, No 3, Jul-Sep 84 (manuscript received 16 Apr 84) pp 235-239

POLYAKHOVA, Ye. N., Leningrad State University imeni A. A. Zhdanov

[Abstract] A study was made of a Keplerian elliptical cometary orbit experiencing some nongravitational perturbing acceleration with the components S, T, W in an orbital coordinate system. After writing the equations for perturbed motion, the equations are averaged (this requires stipulation of the law of changes of perturbing nongravitational acceleration as a function of heliocentric distance r). A simplified law of continuous change in the components of reactive acceleration is selected and the rates of secular changes in the elements of the cometary orbit under the influence of

nongravitational reactive acceleration are determined. Formulas are derived which can be used in predicting cometary orbits. It is shown that the components of relative velocity of gas escape can attain several kilometers per second. The estimates made by the proposed method are consistent with the high velocities of axial rotation of the nucleus of Halley's comet. With rapid rotation of the nucleus the radial gas jet initially directed toward the sun as a result of thermal inertia continues to rotate together with the escape sector. This causes the appearance of a transversal component of reactive acceleration capable of introducing a correction into the orbital motion of the comet. References 8: 3 Russian, 5 Western.
[190-5303]

UDC 523.165:523.72

CORRELATION OF INTERPLANETARY MEDIUM PARAMETERS IN TRANSITION REGION OF HIGH-VELOCITY SOLAR WIND STREAMS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 24, No 3, May-Jun 84 (manuscript received 1 Nov 83) pp 376-380

MYMRINA, N. V., DORMAN, L. I., KAMINER, N. S. and KUZ'MICHEVA, A. Ye., Terrestrial Magnetism, Ionosphere and Radio Wave Propagation Institute, USSR Academy of Sciences; Ural Pedagogic Institute imeni A. S. Pushkin

[Abstract] Investigations of variations in the intensity of galactic cosmic rays (GCR) during presence of the earth in high-velocity streams (HVS) of the solar wind which are associated with coronal holes have shown that the structure of HVS and characteristics of the medium exert a considerable influence on the distribution of cosmic rays in the interplanetary medium. The transition region between the quiet solar wind and HVS, where a significant anisotropy of cosmic rays arises, is of considerable importance. These phenomena were studied using data from the King catalogue for the period 1973-1974 (declining solar activity) when there was a great number of HVS, of which 62 with a velocity 500-800 km/sec were selected for analysis. This made it possible to obtain a number of relationships between the parameters of the streams. Some of these relationships confirm and supplement the results obtained earlier and some are new. It was discovered that there is a close correlation between the transverse dimensions of the HVS and the maximum velocity of plasma in the stream. This agrees well with the known correlation between the dimensions of coronal holes and the velocity of HVS if it is assumed that the size of the coronal hole and the width of the HVS are closely correlated. A slowing of increase in v_{max} for very wide streams suggests that the maximum velocities of plasma in the HVS are close to 800 $km \cdot sec^{-1}$ and should be close to solar wind velocities in the sun's polar regions. A weak correlation between ΔB and Δn can be attributed to the fact that ΔB and Δn characterize interaction between slow and fast solar wind plasma whereas v_{max} is related to the conditions for the appearance of HVS. The correlation coefficients between different parameters usually increase with an increase in v_{max}. The existence of a negative correlation

between variability of the σ_B field in HVS and v_{max} confirms the known increase in the $D_{\parallel}/D_{\perp}$ ratio of the coefficients of longitudinal and transverse diffusion of cosmic rays in HVS but also shows that this increase is proportional to the velocity of the HVS. Figures 3, tables 1; references 11: 4 Russian, 7 Western.
[175-5303]

UDC 523.165

CHARACTERISTICS OF LATITUDE EFFECT ON COSMIC RAY CHARGED COMPONENT IN ATMOSPHERE AT ALTITUDES 3-5 KM

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 24, No 3, May-Jun 84 (manuscript received 13 Oct 82, after revision 11 Apr 83) pp 386-392

ALTUKHOV, A. M., AGESHIN, P. N., KRASOTKIN, A. F., ROGOZHIN, V. A., SENCHENOK, V. M., CHARAKHCH'YAN, A. N. and CHARAKHCH'YAN, T. N., Institute of Nuclear Physics, Moscow State University

[Abstract] Anomalies in the latitude distribution of the charged component of cosmic rays in the lower atmosphere were discovered on the basis of the results of measurements of cosmic rays in the stratosphere. Over periods of a year or more there is an inverse latitude effect (up to 5-10%) between Murmansk and Moscow and an N-S asymmetry up to 10-15% according to Murmansk and Mirnyy data. These latitude anomalies are unrelated to geomagnetic effects in cosmic rays. These unexplained facts dictated detailed study of the latitude and longitude distributions in the lower atmosphere. An airborne B-1 instrument aboard an aircraft flying at altitudes 2-10 km (measurements at 2-4 km were made for the first time anywhere) was used in measuring the global, vertical and horizontal fluxes of charged particles. The instrument detectors were STS-6 gas-discharge counters. The instrument has four blocks, each of which has 20 counters. Registry was in seven channels. Figures 1 and 2 are diagrammatic representations of the B-1 instrument. Measurement data for four locations in the USSR were analyzed. At each of these locations measurements were made at the same nine isobaric levels corresponding to altitudes 2, 3, 4, 5, 6, 7, 8, 9 and 10 km. Measurements at each level lasted 10-12 minutes. This made it possible to obtain reliable data on the nature of the vertical variation of latitude and longitude effects of the charged component of cosmic rays. None of the data collected in these experiments contradicts data in the literature. There are various contradictions between surface and aircraft data which cannot be attributed to any reasonable variations in the spatial and energy characteristics of galactic cosmic rays. It may be that the anomalies discovered in the latitude distribution of cosmic rays are related to unknown phenomena of a meteorological nature or some unknown radiation which makes a contribution to the charged component of cosmic rays and makes no significant contribution to the nucleon component. It is noteworthy that there is a rather marked change in the properties of zonal modulation of cosmic rays with a change in the direction of the sun's total magnetic field. The nature

of the anomaly in the latitude distribution of cosmic rays in the lower atmosphere changes sharply after 1971, after a change in sign of the sun's total magnetic field. A well-expressed latitude asymmetry in the northern hemisphere up to 1971 was replaced by a well-expressed longitude asymmetry after 1972. Figures 4, tables 5; references 7: 4 Russian, 3 Western.
[175-5303]

UDC 523.72

HYDROMAGNETIC PRECURSORS OF INTERPLANETARY PLASMA BURST

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 24, No 3, May-Jun 84
(manuscript received 13 Jun 83) pp 489-491

GUL'YEL'MI, A. V. and IVANOV, K. G., Earth Physics Institute, USSR Academy of Sciences; Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, USSR Academy of Sciences

[Abstract] Earlier (SPACE SCI. REV., 16, 331, 1974), the author proposed (and experimentally validated) the idea that waves from the region in front of the shock front of a burst of interplanetary plasma penetrate into the magnetosphere and are observed on the earth in the form of Pc3 pulsations. It was postulated that before the plasma burst (PB) touches the magnetosphere it would be possible to observe specific magnetic field pulsations caused by the penetration into the magnetosphere of hydromagnetic waves which precede the PB. This article describes the phenomenon and gives an analysis of observational data. First, the frequency of pulsations is estimated within the framework of the theory of cyclotron instability of protons reflected from the shock front. It is shown that the frequency of Pc3 magnetic pulsations is related to B (interplanetary magnetic field) by the empirical expression $f = 5.7 \pm 1.6$ B; observations in the neighborhood of other planets give $f \approx 5.8$ B. This fully confirms the theory and makes possible its application to PB. At the earth, PB precursors must be sought in the form of geomagnetic pulsations outpacing the sudden commencement of a magnetic storm (SSC). The geometry of interaction between the PB and the earth's magnetosphere suggests the following estimate of the mean advance time: $\Delta t \approx 0.5R/(U+M_1A)$. Here R is the radius of curvature of the PB front. With $R \sim 3 \cdot 10^{12}$ cm, $U \sim 4 \cdot 10^7$ cm/sec, $M_1 \sim 3$, $A \sim 5 \cdot 10^6$ cm/sec the advance time is: $\Delta t \sim 8$ hours. The same problem is examined for other planets of the solar system. References 14: 4 Russian, 10 Western.
[175-5303]

UDC 523.165

LONGITUDE AND PITCH-ANGLE DISTRIBUTIONS OF STREAMS OF HIGH-ENERGY ELECTRONS UNDER EARTH'S RADIATION BELTS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 24, No 3, May-Jun 84 (manuscript received 22 Aug 83) pp 494-495

AVERIN, S. A., GAL'PER, A. M., GRACHEV, V. M., DMITRENKO, V. V., KIRILLOV-UGRYUMOV, V. G. and ULIN, S. Ye., Moscow Physical Engineering Institute

[Abstract] The results of measurements of fluxes of electrons with energies E_e=460 MeV in a wide range of longitudes and pitch angles are given, together with the experimental dependences of the mean fluxes of albedo and quasi-trapped electrons (determined from the pitch-angle and longitude distributions) on the drift shell parameter L and the geomagnetic cutoff rigidity threshold. The measurements were made using the "Yelena-F" gamma-telescope on the "Salyut-6" orbital station with definite spatial orientations of the station and instrument. The station had an orbital inclination of 51.6°. There were nine measurement sessions with different telescope positions relative to the station axes. On the basis of the pitch-angle distributions and results of computations of the limiting pitch angle separating electrons into albedo (having reflection points in the northern and southern hemispheres below the altitude $h < 60$ km) and quasitrapped (by the geomagnetic field ($h \geqslant 60$ km)) particles it was possible to determine the fluxes of electrons of both types. Within the limits of experimental accuracy they are described well in the interval L = 1.0-2.3 by straight lines whose equations for albedo electrons have the form:

$$\overline{I}_a \approx (6.7L + 5)\cdot 10^2 \ (m^2\cdot sec\cdot sr)^{-1}$$

and for quasitrapped electrons

$$\overline{I}_q \approx (3L - 1.7)\cdot 10^2 \ (m^2\cdot sec\cdot sr)^{-1}.$$

The observed increase in the fluxes of albedo and quasitrapped electrons with an increase in L is related to the latitude effect of primary cosmic rays. Figures 2; references: 5 Russian.
[175-5303]

UDC 521.134

LAGRANGIAN SOLUTIONS IN PHOTOGRAVITATIONAL RESTRICTED CIRCULAR THREE-BODY PROBLEM

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 3, May-Jun 84 (manuscript received 30 Sep 82) pp 564-570

LUK'YANOV, L. G., State Astronomical Institute imeni P. K. Shternberg

[Abstract] Lagrangian solutions in the photogravitational restricted circular three-body problem are obtained. The problem is formulated as follows. It is assumed that the main bodies M_1 and M_2 with the masses $1 - \mu$ and $\mu (\mu \leqslant 1/2)$ move under the influence of reciprocal attraction in circles with a unit angular velocity, the distance between them being assumed equal to unity. A study is made of the motion of a body M of small mass caused by the main bodies and characterized by the force function

$$U = \frac{q_1(1 - \mu)}{r_1} + \frac{q_2 \mu}{r_2}$$

where r_1 and r_2 are the distances between the M body and the main bodies M_1 and M_2 respectively, q_1 and q_2 are some constant parameters. When $q_1 = q_2 = 1$ the classical restricted three-body problem is obtained. Depending on the characteristics of the emitting body and the size and mass of the M body the q_1 and q_2 values can assume values in the range $(-\infty, +1]$. The existence of liberation points in the range of change of q_1 and q_2 from 0 to 1 was examined earlier; in those studies negative q_1 or q_2 values were examined only on the assumption that one of them is equal to unity. The authors of this article explore this problem in greater depth, investigating the existence of linear and triangular libration points in the restricted photogravitational problem of three bodies for any real q_1 and q_2 values from $-\infty$ to $+\infty$. Broadening of the range from 1 to $+\infty$ is usually not necessary within the framework of the photogravitational problem because q_1 and q_2 cannot be greater than 1. However this range can be of interest for other physical problems, such as in allowance for Coulomb forces for charged particles. There is a possibility of the existence of two linear libration points between the main bodies or beyond one of them and even three libration points between the main bodies. Regions of existence of Lagrangian solutions were determined in the plane of q_1 and q_2 parameters. Figures 5, tables 1; references: 3 Russian.
[174-5303]

UDC 629.783:523.3/5:521.11

NONTRADITIONAL METHOD FOR DETERMINING UNPERTURBED ORBITS OF UNKNOWN SPACE OBJECTS USING INCOMPLETE OPTICAL OBSERVATIONAL DATA

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 3, May-Jun 84 (manuscript received 24 Feb 83) pp 571-576

PEROV, N. I., Yaroslavl' State Pedagogic Institute

[Abstract] A geometrical method for determining the orbits of artificial earth satellites (AES) when using an excess number of observations ($n > 3$) was published by V. I. Kuryshev and N. I. Perov in ASTRON, ZH., 59, 1212, 1982. Proceeding along these lines, the author is developing a "physical-geometrical" method for computing the orbits of earth satellites on the basis of an inadequate number of angular observations ($n < 3$). Specifically, a new method has been developed for calculating the elements of Keplerian orbits of unidentified artificial satellites using two angular observations (α_k, δ_k, s_k, $k = 0.1$). The first section of the article gives procedures for determining the topocentric distance to AES on the basis of one optical observation. This is followed by description of a very simple method for determining unperturbed orbits using two satellite position vectors and a time interval which is applicable even in the case of antiparallel AES position vectors, a method designated the r_2 iterations method. (In this method the initial data are two values of the geocentric radius-vector of the object r_0, r_1 and the time interval $T_1 - T_0$ between observations, the sought-for parameters being the elements of the Keplerian orbit of the space object.) A specific example of the computations is given. The described procedures broaden the possibilities of classical methods for determining the orbits of celestial bodies. They can be used in the search for and detection of faint space objects, in estimating topocentric distance and an AES on the basis of one optical observation and in determining orbits of earth satellites on the basis of two optical observations. Tables 3; references: 11 Russian.
[174-5303]

UDC 521.4

COMPUTATION OF ELLIPTICAL FUNCTIONS IN PROBLEMS OF CELESTIAL MECHANICS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 61, No 3, May-Jun 84 (manuscript received 17 Mar 83) pp 609-610

GERASIMOV, I. A., State Astronomical Institute imeni P. K. Shternberg

[Abstract] Elliptical functions are widely used in celestial mechanics in the theory of motion of artificial earth satellites and resonance asteroids, in qualitative study of the restricted three-body problem and in simple computation of Laplace coefficients. However, advances in

computer technology dictate a reexamination of existing algorithms for computing elliptical functions for increasing their accuracy. Having the k modulus, it is usually necessary to find the value of the elliptical function for a stipulated argument u. The easiest way to do this is a changeover to theta functions, which are power series relative to the q parameter with coefficients being trigonometric functions of the argument u. Using expressions of the elliptical functions through the theta function, it is relatively easy to compute the required function. The fundamental problem is therefore a determination of the q parameter on the basis of the known k value. Formulas are derived for computing the theta function with high precision. A numerical example of the computations is given. References: 8 Russian.
[174-5303]

UDC 629.197.2

ALGORITHM FOR DETERMINING OPTIMAL THREE IMPULSE POINT-TO-ORBIT TRANSFER WITH LIMITED TRANSFER TIME

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 27 May 82) pp 3-12

IVASHKIN, V.V. and SKOROKHODOV, A.P.

[Abstract] A spacecraft transfers from an initial orbital point in a central Newtonian gravitational field to a final elliptical orbit. The planetocentric distance and the radial and transverse components of the spacecraft velocity are specified at the initial point in time. At the final point in time, only the pericentric and apocentric distances or a focal parameter and energy constant are specified. This paper describes an algorithm for the determination of the space vehicle transfer which is energy optimal when the transfer flight time is constrained and the transfer is accomplished with three impulse maneuvers. The algorithm is based on an indirect optimization technique which derives the optimal trajectory from a single parameter family of trajectories which are optimal given the time constraint and obvious distance limitations. The initial approximation of the relevant boundary value problem is the well known solution of the case of a free transfer flight time. The variable parameters of the boundary value problem are analyzed in detail and the resulting algorithm with 12 main steps is discussed. The program includes about 1,000 Fortran operators (about 8,000 machine words following translation, without considering the standard routines for the elementary functions and work with the matrices) and was run on the YeS-1040 computer. Data are provided for a sample circulation of a transfer between circular orbits with a ratio of the orbital radii of 1:20. In a number of cases, the three-impulse solution was found for short transfer times when the apsidal solution of the usual free flight time case is not optimal. Figures 2; tables 1; references 12: 8 Russian; 1 Western; 3 Western in Russian translation.
[125-8225]

UDC 531.391

MOTION OF SYMMETRICAL SATELLITE WITH FLEXIBLE VISCOELASTIC RODS ABOUT CENTER OF MASS IN CIRCULAR ORBIT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84
(manuscript received 7 Apr 82) pp 13-19

BOLOTINA, N.Ye. and VIL'KE, V.G.

[Abstract] A symmetrical satellite moves in a circular orbit in a central Newtonian force field. The satellite has two flexible rods positioned along its axis of symmetry. A system of coordinates is tied to the satellite with the origin at the center of mass of the system in the position when the rods are straight. An additional translationally moving system of coordinates is also used to completely describe the evolution of the rotational motion of the satellite. This paper derives approximate equations describing the system dynamics based on an averaging technique using Anduay variables. The purely theoretical treatment adduces no applications or sample calculations. [125-8225]

UDC 517.11

REJECTION OF ANOMALOUS OBSERVATIONS WHEN DETERMINING SPACECRAFT TRAJECTORIES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84
(manuscript received 4 Feb 82) pp 20-36

SAVRASOV, Yu.S.

[Abstract] The majority of techniques used to reject coarse anomalous observation errors when tracking space vehicles is based on procedures which smooth the observations with a polynomial of some degree. Although simple, this approach entails a large volume of computations. A more economical method which precludes the necessity of preliminary smoothing is possible and eliminates the problem of the optimal choice of the degree of the smoothing polynomial. The major task of processing an observational sample consists in discriminating the set of measurements which does not contain anomalous data. This problem is solved here in three steps, involving the generation of an initial sample of measurement residuals, followed by the discrimination from the remaining residuals of new measurement residuals which can be included in the initial set and then applying particular criteria to split the initial sample into one set of valid measurement residuals and a set of anomalous residuals. The decision making criteria are based on the theory of order statistics. Three specific cases considered are: 1) The initial measurement error residuals have uniform distributions; 2) The errors have a normal distribution and 3) The measurement errors have a normal distribution only in a narrow range. The case when there is either one anomalous observation in a sample or several with

approximately equal errors is also analyzed. Probability statistics are found which enable the estimation of the efficiency of the criteria derived in spacecraft trajectory determinations. A comparison of this new approach with previous smoothing techniques shows that, depending on the criteria applied, it is 300 to 600% more economical in terms of computer time and 50% better as regards memory requirements. Figures 7; references 10: 8 Russian; 2 Western in Russian translation.
[125-8225]

UDC 531.28

OPERATIONAL EXPERIENCE WITH ION CONCENTRATION SENSORS IN ORIENTATION SYSTEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 26 May 82) pp 37-43

LEGOSTAYEV, V.P., NIKOLAYEV, V. D., SAULIN, K.I., SUKHOVOY, M.B. and UL'YANOV, Ye.G.

[Abstract] Space vehicle orientation relative to the direction of flight is found directly within a few seconds' time by means of ion sensors which measure the concentration of ions in the flow incident to the spacecraft. The ion detectors are the sensitive elements positioned at an angle with respect to the axis of the craft and generate the difference signals used to find the vehicle orientation. This paper reviews the history of first and second generation ion flow type orientation sensors. The following conclusions are made: the detectors and orientation systems which have been developed have working altitudes of more than 1,000 km, determine the direction of an incident ion flow in an angular deviation range of no less than $\pm 90°$ and provide information on the position of the incident ion flow for approximately 90% orbital period of the vehicle. The need for a nominal orientation precision as high as 0.1° is responsible for the following approaches to third generation system design: 1) The introduction of variable setting of the ion sensor (the nominal ion concentration) as a function of the working altitude in each phase of the flight; 2) Producing a digital output signal from the ion detector, interfacing it with a digital computer and developing the software for the periodic correction of the oriented position; 3) Implementation of automatic testing of the measurement accuracy of ion sensing chamber functioning by means of rocket motor pulses, generation of gas flows in particular directions and rotation of structural elements or other effects on the incident ion flow. Figures 3; references: 3 Russian.
[125-8225]

UDC 581.521

PROTONS WITH ENERGIES ABOVE 30 KeV IN EARTH'S RADIATION BELT AT LOW ALTITUDES DURING MAGNETICALLY QUIET TIME CLOSE TO GEOMAGNETIC EQUATOR

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 11 May 82) pp 53-66

VLASOVA, N.A., KNYAZEV, B.N., KOVTYUKH, A.S., KOZLOV, A.G., PANASYUK, M.I., REYZMAN, S.Ya. and SOSNOVETS, E.N.

[Abstract] The Molniya-1, Molniya-2 and Cosmos-900 satellites launched between 1970 and 1977 carried differential proton spectrometers (the latter two also carried an alpha particle and proton spectrometer) which measured energies between 31 KeV and 50 MeV. Reduction of these data show: 1) differential energy spectra of protons with energies above 30 KeV close to the geomagnetic equator at middle latitudes are characterized by a maximum in the E layer of hundreds of KeV, which shifts to higher energies as the shell level number L decreases. This is explained by the Coulomb losses and excess proton charges during the radial drift of protons into the radiation belt. Proton spectra are monotonic at an altitude of about 500 km, having an intensity which falls off as the energy increases. The proton spectra at these low altitudes can be described by a model showing the development of strong pitch angle diffusion at the high latitudes of the outer radiation belt; 2) the near-equatorial proton spectra when $L \geq 4$ can be approximated by a simple exponential function or by the superimposition of the thermal Maxwellian and nonthermal tail in the form of a power function. The probable source of protons in this energy range is the plasma layer. When $L < 4$, a power function is the most acceptable approximation in the region of the high energy tail of the proton spectra; 3) the change in the characteristic energy of the spectra in the outer radiation belt region ($L > 4$) indicates the existence of a weaker dependence on L than follows from the expression when the energy $E \simeq L^{-n}$, where $2.4 \lesssim n \lesssim 3$, which is characteristic of betatron acceleration with particle transport deep into a radiation belt; 4) the region of proton precipitation is formed at $L > 3$ with a maximum at $L \simeq 6$ or 7 on the night side. The position of the maximum is slightly dependent on L with an energy variation in a range of from about 50 KeV to about 1 MeV. Figures 4; references 31: 13 Russian, 17 Western, 1 Western in Russian translation.
[125-8225]

UDC 550.385.41

ONE-DIMENSIONAL MODEL OF AURORAL MAGNETIC FORCE TUBE WITH LONGITUDINAL CURRENT AND CYCLOTRON HEATING OF IONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 17 Mar 83) pp 67-86

VOLKOV, M.A., VOLOSEVICH, A.V. and GAL'PERIN, Yu. I.

[Abstract] Aurora structural models are developed which are oriented towards computations of the altitude profiles of the electron concentration above an auroral oval and are suitable for comparison with experimental data from satellites such as the "Oreol-3" of the joint Soviet-French ARKAD-3 project. Quiet auroral arcs are characterized by the maximum possible extension in length (on the order of the transverse dimension of the plasma layer) while three difference scales are discriminated in latitude for discrete auroral forms. The characteristic scales of aurora structure, characterized by sharp changes in the energetic electron flux, which in turn cause the polar aurora and ionization and consequently spatial changes in the ionospheric conductivity, comprise the basis for estimates of the characteristic longitudinal current. A steady-state system of drift kinetics equations are written and solved for ionospheric ions accelerated along a dipole force tube, taking into account the anisotropy of the perpendicular and parallel components of the temperature for the first two of the above three characteristic scales. Stable solutions exist for the auroral force tube only in the presence of a supersonic ascending flow of ionospheric ions. For the case of realistic values of the longitudinal current density, ions of ionospheric origin are the dominant ones (in terms of concentration and energy density) at the upper boundary of the acceleration region. With an increase in the difference between the parallel and potential components, the overall particle concentration falls off at the upper boundary, simulating the observed formation of an "auroral cavity" above the oval. Cyclotron heating of the ions at the level bounded by the widening of the ion resonances increases the perpendicular temperature component by only a few tens of eV, which is insufficient to explain the "conical beams" when this component is greater than about 0.1 to 1 KeV. Two appendices deal with the derivation of the drift kinetics equations and the calculation of the concentration of noncolliding charged particles along the force tube and the limits of integration in the H, μ plane in considerable detail. Figures 4; references 75: 14 Russian, 61 Western.
[125-8225]

UDC 523.035:525.72

HELIUM ATOMS IN INTERSTELLAR AND INTERPLANETARY SPACE. II. DETERMINATION OF DIRECTION OF INTERSTELLAR GAS MOTION RELATIVE TO SUN

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 12 Sep 83) pp 97-102

KURT, V.G., MIRONOVA, Ye.N., BERTO, Zh.-L. and DALOD'YE, F.

[Abstract] The far ultraviolet photometer on board the Prognoz-6 satellite measured the brightness distribution in the 584 Å line of atomic helium in interplanetary space. Since atoms of neutral helium penetrate deeper into the solar system than neutral hydrogen and are focused by the sun's gravitational field, it is possible to determine the direction of the vector V_w, which is the sum of the interstellar gas velocity vector V_t and the vector $-V_s$ which is the velocity vector of the sun relative to several hundreds of the closest stars. The scanning geometry of the photometer system is illustrated graphically and the data from seven observational sessions between 29 Sep 1977 and 15 Jan 1978 are summarized in tabular form. The velocity vector projected onto the celectial sphere (V_s) has a right ascension of $77 \pm 2°$ and a declination of $17 \pm 2.5°$. The authors are grateful to M.S. Burgin and V. V. Teodoronskiy for the composition of the computer program. Figures 6; tables 1; references 4: 3 Russian, 1 Western. [125-8225]

UDC 523.745

ROCKET BODY CHARGE NEUTRALIZATION PROCESSES IN 'ARAKS' EXPERIMENT (DATA FROM TWO LAUNCHES)

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 3 Jun 82) pp 103-109

MANAGADZE, G.G. and LYAKHOV, S.B.

[Abstract] In the ARAKS experiments, two identical narrow beam ($2 \cdot 10^{-2}$ sr) transducers of the "Ushba" electron spectrometer scanned an energy range of 1 to 16 KeV every 10 msec from orientation angles of 75 and 120° relative to the longitudinal axis of the test rocket in order to determine the nature of the neutralization of the charge built-up on a spacecraft when electrons are injected from the craft given the condition that the neutralization current due to thermal electrons in the unperturbed ionospheric plasma is much less than the injection current (by a factor of about 10^3). The steady-state potential of a rocket body at the moment of electron injection at altitudes over 150 km exceeds 1 KV and is governed by the current from a supplemental neutralization current source. The potential at times briefly become commensurate with the accelerating voltage of the electron injector and leads to the cessation of injection. Western evidence

of significant spacecraft charging by an electron accelerator at ionospheric altitudes is also cited. Figures 4, references 27: 9 Russian, 18 Western. [125-8225]

UDC 541.6:523.3

COSMOGENIC ^{22}Na AND ^{26}Al IN 'LUNA-24' LUNAR DRILL CORE SOIL SAMPLES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 17 May 82) pp 110-119

LAVRUKHINA, A.K., POVINETS, P. and USTINOVA, G.K.

[Abstract] Drill core soil samples taken 18 km east of the crater Fahrenheit by the Luna-24 were subjected to nondestructive low background laboratory beta-gamma-gamma spectrometry to measure the ^{22}Na and ^{26}Al radioactivity at the I.A. komenskiy University in Bratislava. The analyses of samples 24118.4-4, 24143.4-4 and 24184.4-4 show: 1) at depths below about 40 cm, the drilling did not cause any intermixing of the soil in the core; 2) the regolith surface layer at the Luna-24 site has remained constant for the last million years; 3) the average galactic cosmic ray intensity greater than 0.5 GV has not varied by more than about 20% and has thus been at the present average intensity of 0.24 particles$\cdot$cm$^{-2}\cdot$s$^{-1}\cdot$sr^{-1}. The chemical composition of soil core samples is summarized in tabular form and the data are used to plot the depth distribution of ^{22}Na and ^{26}Al. These profiles are compared with theoretical profiles calculated analytically. The slight disparity between experiment and theory is explained in terms of chemical composition of the samples and the role of random processes over the last 6 million years is examined briefly. Figures 6; references 34: 10 Russian, 24 Western.
[125-8225]

UDC 621.031

ROTATIONAL MOTION OF A SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 20 Apr 82) pp 130-131

KHENTOV, A.A.

[Abstract] The equations of motion for a satellite with unequal central moments of inertia relative to its own center of mass when in the field of a gravitational center have a special case solution for satellite rotation about a normal to its orbit. This is valid when one of the main central axis of inertia is collinear with a normal to the orbit (Keplerian orbit) while the two other axes are in the orbital plane. This paper analyzes the case when an angle is present between one of the latter inertial axes and a

vector directed from the center of gravitation to the satellite center of mass. The resulting second order differential equation which is written as a function of the eccentricity of the orbit, the true anomaly and the moments of inertia of the satellite relative to the three major axes is best solved by asymptotic and numerical techniques. The impact of the moments of inertia and the eccentricity on the conditions necessary for an exact solution is ascertained. It is shown that a definite solution is stable in terms of Lyapunov's criterion if the eccentricity is less than 0.32046 or falls between 0.9004 and 0.9174. Figures 1; references: 5 Russian.
[125-8225]

UDC 531.55

SATELLITE OSCILLATIONS IN ELLIPTICAL ORBIT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 18 Apr 83) pp 133-134

BUROV, A.A.

[Abstract] The planar oscillations of a satellite in an elliptical orbit are described by a system of first order canonical differential equations written in terms of a Hamiltonian function which is analytical in a specified range of eccentricities. With sufficiently small values of the eccentricity this system of equations possesses a single parameter family of hyperbolic solutions which attain equilibrium when the eccentricity is zero. The solution of the equation is found for the case of a coordinate system tied to the satellite center of mass and the effect of the eccentricity on satellite oscillation stability is described mathematically. The conditions for a unique periodic solution of the system are also defined. The purely theoretical analysis adduces neither sample calculations nor applications. The author is grateful to V.V. Kozlov for his attention to the work. References 3: 2 Russian, 1 Western.
[125-8225]

UDC 523.72

OBSERVATION OF COSMIC RAY FLUX VARIATIONS IN STRATOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 28 Jun 82) pp 134-136

BARANNIKOV, Yu.I., BARSUKOV, O.A. and GAVRILOV, P.F.

[Abstract] Studies of cosmic rays in the stratosphere were conducted during 1975-1981 using balloons and high altitude aircraft. The latter flew the route from Alma-Ata -- Moscow -- Murmansk at altitudes of 16 to 20 km and had equipment for measuring the vertical proton flux with energies

of E_p = 350 to 1,000 MeV, the omnidirectional neutron flux at energies of E_n = 0.025 eV + 10 MeV and the omnidirectional charged particle flux with energies of $E_e \gg 1.3$ MeV and $E_p > 20$ MeV. The balloons measured the vertical electron flux in an energy range of 50 to 500 KeV. All the data indicated the existence of pulsating cosmic ray flux variations in the auroral region with characteristic pulsation times of 150 to 400 sec. Possible mechanisms generating these pulsations include pulsations of the solar diameter or oscillations of the solar surface which cause pulsations in the density and velocity of the solar wind and consequently the interplanetary magnetic field. It is noted that the natural period of magnetospheric line of force oscillations for latitudes of about 70° N is approximately 400 sec. This agrees with the authors' data. The discussion of these possible mechanisms draws no firm conclusions though it is indicated that geomagnetic pulsations are related to the preflare situation on the sun, a relationship which should also be observed in the cosmic ray flux pulsations in the stratosphere, which in turn can be used for short term forecasting of solar cosmic rays in the earth's atmosphere. Figures 2; references 16: 13 Russian; 3 Western.
[125-8225]

UDC 551.510.535.4

INCREASE IN HYDROGEN EMISSION OF UPPER ATMOSPHERE FOLLOWING LAUNCHES OF SPACE VEHICLES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 17 Feb 83) pp 136-137

MARTSVALADZE, N.M. and FISHKOVA, L.M.

[Abstract] An increase in the amount of hydrogen in the upper atmosphere is attested by a slight enhancement of the normalized hydrogen-alpha emission intensity observed an average of 2 - 6 days after spacecraft launches. These observations of the 656.3 nm emission line in the nighttime sky spectrum were made at the Abastumani Astrophysical Observatory of the Georgian Academy of Sciences between 1968 and 1978. This paper is a continuation of the work, extending the comparison of irregular variations in the hydrogen emission with the launch dates of a number of foreign spacecraft using data published in the Great Soviet Encyclopedia yearbooks. The analysis was applied only to spacecraft with an apogee above 800 km, starting with the INTELSAT-3C (F-3) in 1969 and concluding with the Navstar-2, DSCS-13 and DSCS-14 in 1979. The deviations in the alpha line intensity from the average season values is plotted as a function of time in terms of days before and after the launch date. There is an increase in the excess hydrogen line emission intensity in the winter, some 3 - 6 days after a launch with a maximum upward deviation 4 - 5 days following the launch. The effect is not observed in the summer. Figures 1; references: 4 Russian.
[125-8225]

UDC 522.1:523.14

DETERMINATION OF ANGULAR RESOLUTION OF CODED APERTURE GAMMA-RAY TELESCOPE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 2 Jun 82) pp 141-143

KOTOV, Yu.D., LAZAREV, S.A., LUCHKOV, B.I., SMIRNOV, Yu.V. and YUROV, V.N.

[Abstract] While the angular resolution of the best modern gamma-ray telescopes using spark chambers is about 2° for gamma quanta energies in the 100 MeV range, aperture coding by inserting a coding screen in front of the detector can increase the resolution to 1' - 10' while cutting the effective aperture of the telescope in half. This paper describes an experiment using a beam of tagged gamma quanta from the "Pakhra" accelerator to calibrate second generation gamma-ray telescopes. A one-dimensional coding screen with 19 elements (10 transparent teflon elements and 9 lead absorbing elements) was used. The screen was 15 mm thick. It is shown that high energy gamma ray telescopes using this technique can achieve an angular resolution of a few minutes. This is demonstrated here for a gamma quanta energy of 100 MeV and for the bremsstrahlung spectrum of gamma radiation corresponding to cosmic gamma radiation sources. A low frequency filtering technique employing a discrete Fourier transform was used on the resulting images and is briefly described. The authors express their gratitude to A.M. Gal'per, O.F. Prilutskiy, Yu.V. Ozerov and Ye.P. Chichova for their assistance and interest in the work. Figures 3; references 10: 7 Russian; 2 Western; 1 Western in Russian translation.
[125-8225]

COMMITTEE DISUCSSES UPCOMING 'VEGA' FLIGHTS

Tallinn SOVETSKAYA ESTONIYA in Russian 14 Nov 84 p 3

[Excerpt] A meeting of the International Consultative Committee for the Study of Halley's Comet began in Tallinn on 13 November. Participants in this meeting are to share views on the work that has been done and outline ways of further preparing for the encounter with this comet.

V. Kotel'nikov, vice-president of the USSR Academy of Sciences and chairman of the Intercosmos Council, spoke at the meeting. He said that the Soviet spaceships "Vega-1" and "Vega-2" will be the first to make the trip to the comet. The paths of subsequent flights by spacecraft of other countries will be corrected on the basis of the Soviet spaceships' flight. Scientists hope that this space experiment will serve the cause of peace and friendship and the strengthening of international ties on all levels.

Also taking part in the conference and giving addresses were R. Sagdeyev, member of the USSR Academy of Sciences, director of the academy's Institute of Space Research and head of the delegation of Soviet scientists and specialists; and K. Rebane, corresponding member of the USSR Academy of Sciences and president of the Estonian Academy of Sciences.

FTD/SNAP
CSO: 1866/55

PROJECT HEAD KOVTUNENKO DISCUSSES 'VEGA' PROJECT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 84 p 3

[Article by G. Lomanov, correspondent]

[Excerpt] At the planet where interplanetary stations are built, an unusual spacecraft with a metallic luster stood on a stand in the huge assembly room. Nearby, a snow-white sphere suspended from the ceiling and resembling a weather balloon floated in the air.

"This is indeed a weather balloon, but a Venusian one," explained the head of the "VEGA" project, corresponding member of the Ukrainian Academy of Sciences Vyacheslav Mikhaylovich Kovtunenko. "And the spacecraft is an exact copy of the interplanetary stations which will fly to the Morning Star."

We won't have to wait much longer. In December, two automatic stations will start their journey from the Baykonur cosmodrome. In June of next year, they will release landing modules, which are supposed to make soft landings on the surface of the orange planet. But before landing, they will leave helium-filled balloon probes with radio transmitters floating in Venus' atmosphere.

The stations themselves will fly on -- to the mysterious Halley's Comet, which will make its appearance in the vicinity of the Solar System a year and a half from now.

"The stations were built on the basis of a proven design," related V. M. Kovtunenko. "But this does not mean that the designers did not have any problems. A new element appeared -- the aerostatic probe, which is filled with helium. A material for the gas bag had to be found, on which would hold the gas well and would at the same time withstand the long journey folded up, without losing strength at the folds. It also took some thought how to release the balloon. The result was a reliable scheme which we have tested repeatedly in drops of the probe from a helicopter or an airplane."

"Preparations for the encounter with the 'star with a tail' also increased the volume of experimental work," continued V. M. Kovtunenko. "While developing the spacecraft, the designers were aided by a 'model' of Halley's Comet which was created by scientists of the USSR Academy of Sciences' Institute of

Space Research. We were primarily interested in the possible level of dust concentration. Oh yes, the main problem is to protect the instruments from dust. The stations and the comet will approach each other at a velocity of about 80 kilometers per second. At this speed, a dust particle colliding with the spacecraft turns into a little cloud of plasma and burns through the metal. It became necessary to include extra protection and to test the reliability of screens by shooting them with plasma beams."

FTD/SNAP
CSO: 1866/55

TESTS OF VENUS BALLOON PROBES FOR 'VEGA' PROJECT

Moscow IZVESTIYA in Russian 18 Nov 84 p 3

[Article by G. Alimov, correspondent]

[Abstract] The author reports on a test of the balloon-type probe that will be released in the atmopshere of Venus from landing modules of the "Vega" interplanetary stations.

In the test, a sphere-shaped module containing the balloon apparatus and its instruments was dropped from an airplane of the "IL" make. The module was mounted on a platform which was pulled out of the airplane's cargo bay by three parachutes. It is noted that the total weight of this system was 10 tons. Seconds after the drop, the platform fell away, and a parachute opened above the falling module. Ten seconds later, the sphere divided in half. The upper half contained the aerostat gas bag, cylinders with helium, a gondola with scientific instruments, a radio transmitter and a computer. The author's narrative of the sequence from this point is as follows:

"The [computer] counted off 20 seconds, and from the half-sphere there appeared a shining seven-point star. That is how the fragile structure of the aerostat probe looked. For a bit longer... it flew downward, until a large white canopy opened above it. And then amazing evolutions began. The probe appeared to stretch out in an upward direction as it unfolded its mysterious components. I saw how the gas bag appeared, and after it the gondola. Still lower, I saw a silvery ring which, like a plumb, aligned this whole 100-meter caravan along a vertical axis. I learned later that this was a ballast, which just a second earlier was a part of the probe's structure and which contained the probe's most delicate component -- the gas bag."

At this point the gas bag began filling with helium. The helium in the cylinders reportedly was under a pressure of more than 300 atmospheres. The filling with gas took four minutes. The cylinders and the parachute then were jettisoned. The probe continued to fall downward until the ballast was released. The aerostat and its gondola then rose to a prescribed altitude and began to drift.

The article goes on to record comments about the "Vega" project by its chief and deputy chief, Vyacheslav Mikhaylovich Kovtunenko and Roal'd Savvovich Kremnev. They said the aerostat is intended for the study of the mysterious revolution of Venus' cloud cover. Instruments will measure pressure and temperature, and study characteristics of particles in the clouds. The aerostat will begin its drift on the dark side of the planet, and with the clouds will move toward the rising sun. It is expected that the aerostat will drift at least 24 hours. Readings will be recorded simultaneously at tracking stations located in Moscow, Ussuriysk and in the Crimea.

FTD/SNAP
CSO: 1866/55

PREFLIGHT TESTING OF 'VEGA' SPACECRAFT

Moscow KOMSOMOL'SKAYA PRAVDA in Russian 15 Dec 84 p 4

[Article by Yuriy Markov, spacecraft test engineer]

[Abstract] The author comments on the objectives of the upcoming international space probe of the planet Venus and Halley's Comet, and he describes activities at the Baykonur Cosmodrome in preparation for the launching of the USSR's "Vega" spacecraft, which are to be used in this probe.

An account is given of pre-launch tests of equipment and systems of the spacecraft. These tests were nearing completion in the cosmodrome's spacecraft assembling-and-testing building. The author describes some of the ground monitoring-and-testing apparatus which was being used in the tests. High-precision assemblies, new optical-electronic systems and other equipment of the spacecraft were tested in clean chambers, for example. Each liter of air in these chambers can contain no more than 1,300 particles 0.8 micron or more in size. Construction engineer Aleksey Khrupov is identified as one of the builders of the chambers. The preparation of each spacecraft and monitoring-and-testing apparatus for electrical tests began after they had been placed inside a clean chamber.

The author mentions that the tests included the simulated firing of the three stages of a "Proton" launch rocket. The performance of systems that were to operate on the Earth-to-Venus flight was checked in tests which lasted a week. It is also noted that the nucleus of Halley's Comet was simulated with the aid of a laser in tests of the spacecraft's observation equipment.

FTD/SNAP
CSO: 1866/55

TASS REPORTS LAUNCH OF 'VEGA-1' SPACECRAFT

Moscow VECHERNYAYA MOSKVA in Russian 17 Dec 84 p 1

[TASS Report]

[Text] In line with the program of research of outer space and of planets of the Solar System, the automatic interplanetary station "Vega-1" of the space project "Venus--Halley's Comet" was launched on December 15. The station was built in the Soviet Union.

The mission's multipurpose scientific program, which was developed at the initiative of Soviet scientists, calls for carrying out studies of the planet Venus and of Halley's Comet.

In the first stage of the mission of the "Vega-1" station, plans call for a continuation of the study of the atmosphere, cloud cover and surface of the planet Venus with the aid of a landing module, and for carrying out experiments which are new in principle to study the circulation of Venus' atmosphere and its meteorological parameters using an aerostat probe.

Beyond that, the "Vega-1" station will be guided toward a rendezvous with Halley's Comet, and for the first time ever it will perform direct, comprehensive studies of the comet from a fly-by trajectory.

Together with Soviet scientists, designers, engineers, technicians and workers, scientists and specialists of Austria, Bulgaria, Hungary, the German Democratic Republic, Poland, France, the Federal Republic of Germany and Czechoslovakia took part in the development of the complex of scientific apparatus and equipment.

The "Vega-1" station was inserted into the interplanetary trajectory from the intermediate orbit of an artificial Earth satellite.

According to measurement data, the parameters of the flight trajectory are close to the calculated ones. The onboard systems and scientific apparatus of the "Vega-1" station are operating normally.

The station should reach the vicinity of Venus in the middle of June 1985, and pass near Halley's Comet in March 1986.

FTD/SNAP
CSO: 1866/55

TASS REPORTS LAUNCH OF 'VEGA-2' SPACECRAFT

Minsk SOVETSKAYA BELORUSSIYA in Russian 22 Dec 84 p 1

[TASS Report]

[Excerpt] In line with the program of research of outer space and of planets of the Solar System, the automatic interplanetary station "Vega-2" was launched from the Soviet Union on 21 December 1984.

In its design and function, the "Vega-2" station is identical to the "Vega-1" station, which was launched on December 15, 1984.

As was reported earlier, the mission calls for carrying out scientific research of the planet Venus and of Halley's Comet. First the "Vega-2" station will deliver a landing module and an aerostatic probe to Venus, and then it will head for Halley's Comet. The launching of two automatic interplanetary stations will make it possible to increase the length of time of scientific measurements of characteristics of Halley's Comet, and also to study different regions of the planet Venus.

According to measurement data, parameters of the trajectory of movement of the "Vega-2" station are close to the calculated ones. Onboard systems and scientific instruments of the "Vega-1" and "Vega-2" stations are functioning normally.

Scientific information from the stations will be received at the USSR Academy of Sciences' Institute of Space Research for processing and analysis jointly by participants in the experiment -- specialists of Austria, Bulgaria, Hungary, the German Democratic Republic, Poland, France, the Federal Republic of Germany, and Czechoslovakia.

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UDC 523.4

VOLCANISM ON VENUS AS CONNECTING LINK

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 10, No 8, Aug 84 (manuscript received 20 Mar 84) pp 620-630

KSANFOMALITI, L.V., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] Investigations of Venus made during recent years have revealed a number of phenomena which still remain unexplained. These phenomena include electrical activity of the atmosphere, a bimodal distribution of particles in Venusian clouds and variability of properties of the upper cloud layer as indicated by polarimetric and radiometric methods. In this article the author reviews the evidence that volcanic activity on the planet can explain all the mentioned phenomena. For example, the observed electrical discharges are grouped along definite young mountain regions. The low position of the field sources and their fixed positions relative to the planetary surface strongly suggest that the discharges are related to natural relief, in all probability to volcanic eruptions. Although there is no direct evidence of Venusian volcanism, there appears to be no other explanation for the concentration of sources of electromagnetic pulses detected by instrumentation aboard spacecraft. Other indirect evidence of Venusian volcanism is presented. If the observed changes in haze concentration above the cloud layer are actually related to volcanism, polarimetric measurements from the earth might be used in monitoring volcanic activity on Venus. Figures 3; references 43: 14 Russian, 29 Western.
[21-5303]

INTERPLANETARY SHOCK WAVES DURING APRIL AND MAY OF 1981

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 18 Oct 82) pp 87-96

ZASTENKER, G.N. and BORODKOVA, N.L.

[Abstract] Between April 8th and May 20th, 1981, the Prognoz-8 satellite recorded plasma wind and electric field data that made it possible to

determine such parameters of the solar wind as the velocity and temperature of protons and alpha particles separately, the ion concentration and the electric field and plasma flow oscillation spectrum in a range of 2 to 100 Hz. Detailed graphs plot these data as a function of time over this period and show that the interplanetary space experienced an extraordinarily large perturbation at that time. The passage of shock waves is indicated by a simultaneous increase in the velocity, temperature and concentration of ions. A clear correlation is established between the observed shock waves and solar flares. The paper discusses the specific features of the plasma flow before and following the shock wave front in light of the data from nine strong interplanetary disturbances, adducing detailed graphs of the plasma parameters for specific events as a function of time with a resolution of from 4 min down to 10 sec. The authors are grateful to O.L. Vaysberg, Ye.A. Gavrilova, A.N. Omel'chenko, Yu.I. Yermolayev and M.N. Nozdrachev for their assistance with the experiment, the data reduction and the discussion of the results. Figures 4; references 13: 6 Russian, 7 Western.
[125-8225]

UDC - 523.31

ANALYSIS OF SYSTEMATIC ERRORS IN SYSTEMS OF SENODETIC COORDINATES

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 18, No 2, Apr-Jun 84 (manuscript received 12 Apr 83) pp 107-116

NIKONOV, V. A., State Astronomical Institute imeni P. K. Shternberg

[Abstract] A selenodetic network, the Apollo system, was developed on the basis of orbital surveys made from the Apollo spacecraft. It is presently the best dynamic selenocentric coordinate system. The random errors in coordinates of control points in this independent system are 2-3 times less than the random errors of coordinates of points in systems (catalogues) prepared by traditional surface telescopic methods. The author therefore has used the Apollo system as a basis in studying the selenodetic coordinates for detecting the systematic errors which may be present in them, characteristic only of surface methods and not detected earlier due to the lack of an independent basis for comparison. The three best selenodetic catalogues were investigated: D. W. Arthur, COMMUN. LUNAR AND PLANETARY LABOR., Vol 7, Part 5, No 130, pp 303-312, 1968; D. L. Meyer, et al., ICARUS, Vol 4, No 5, 6, pp 513-530, 1965; M. Moutsoulas, MOON, Vol 5, pp 302-331, 1972. These catalogues were compiled using photographs taken at the time of the full moon, the control points being craters with a diameter from 3 to 20 km. It was postulated that the longitudes and latitudes of the control points in these catalogues might contain systematic errors caused by the peculiarities of measurements on lunar photographs taken at the time of the full moon, specifically, those caused by a change in the angles of incidence of the solar rays on the measured object, depending on its position. The careful analysis presented in this article, however, reveals that there are no systematic errors other than those caused by noncoincidence of the coordinate systems. Tables 3; references 21: 11 Russian, 10 Western.
[172-5303]

UDC 535.724:523.42

MICROSTRUCTURE OF VENUS CLOUD LAYER BASED ON SPECTROPHOTOMETRIC DATA FROM VENERA-11 SPACECRAFT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 27 Oct 83) pp 120-129

TITOV, D.V.

[Abstract] The Venera-11 spectrophotometer measured two quantities during its descent to the surface of Venus: 1) intensity of the solar radiation scattered from the zenith in a spectral range of 0.45 to 1.2 μm; 2) intensity of the scattered solar radiation in four broadband filters with continuous zenith angle scanning. An integral Fredholm equation of the first type is written for the aerosol attenuation as a function of wavelength and regularized using a technique of A.N. Tikhonov. It is then used to find the spectra of the cloud particle sizes at altitudes of 48 to 65 km. This analysis of the Venera-11 data shows that a submicron fraction with a radius of less than 1 μm and a high overall concentration of about 10^3 cm^{-1} predominates in the particle size distribution above 60 km (upper cloud layer). The dimensional spectrum gradually widens below 60 km in the central cloud layer. A second set of particles with an average size of about 1.4 μm and an overall concentration of 50 cm^{-1} appears in this region. The index of refraction of the aerosols in the upper and central layers (51 to 65 km), found from the simultaneous interpretation of spectrophotometric and turbidimetric data, is estimated at 1.44 to 1.53. An index of refraction of 1.32 to 1.34 is found for the lower cloud layer at about 50 km. This can be explained either by absorption in the aerosol or the presence of aspherical particles. The author is quite grateful to professor V.I. Moroz for the useful discussion of the data and valuable comments on the work. Figures 5; references 21: 16 Russian; 5 Western.
[125-8225]

UDC 523.42-83:520.88

VISUALIZATION OF RADAR ALTIMETRY DATA FROM VENUS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 22, No 1, Jan-Feb 84 (manuscript received 21 Jul 82) pp 138-140

STANKEVICH, D.G., RED'KIN, S.P., KORNIYENKO, Yu.V., BAZILEVSKIY, A.T. and SHKURATOV, Yu.G.

[Abstract] Altimetric maps supplied by NASA to the USSR Academy of Sciences of the Ishtar region of the Venusian surface (latitude of +45 to +73° and longitude of 315 to 350°) which were derived from the Pioneer Venus Orbiter data were subject to a digital computer image processing technique developed by the UkSSR Academy of Sciences Institute of Radioengineering and Electronics

in order to produce clear three-dimensional maps of the surface relief. The data was supplied as a Mercator projection of 12 uniform altitude gradations of from -1 km to +12 km relative to a level of 6,051 km. Photographs are provided of the raw altimetric data, the representation of the relief as a three-dimensional graph, the depiction of the surface from a vertical perspective with oblique illumination as well as the depiction of the relief in an axonometric projection and a stereoscopic view of the surface. The procedures used are described in brief along with the morphology of the Ishtar region. The authors are also grateful to UkSSR Academy of Sciences academician, A.Ya. Usikov for his useful advice and support of this effort. Figures 5; references 9: 4 Russian, 5 Western.
[125-8225]

UDC: 528.711.1(202):523.42

PRELIMINARY PHOTOMAPS OF VENUS SURFACE IN THE MAXWELL MOUNTAINS AND ADJACENT AREAS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 8, Aug 84 pp 11-16

BOGOMOLOV, A. F. and TYUFLIN, Yu. S.

[Abstract] This article is based on the results of radar mapping of the surface of Venus by the Venera-15 and Venera-16 spacecraft. A preliminary photographic map of the Maxwell mountains and adjacent area constructed from these radar images is presented. Twelve panoramas from the Venera-16 spacecraft obtained from 12 through 23 January 1984 were used to produce the images. The Central Scientific Research Institute of Geodosy, Aerial Surveying and Cartography referenced the panoramas and constructed the parallels and meridians on the maps. Coordinate construction was performed initially for each radar panorama; then, after averaging coordinates at common points, for the entire map. Equations allowing the transition to be made from measured spherical coordinates of points on the radar panorama for known moments in time to venerographic coordinates are presented. All necessary parameters are determined for computation of the coordinates of points on the terrain shown on the radar panoramas. Figures 5.
[9-6508]

UDC 523.42

HYPSOMETRIC FEATURES ON VENUS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 18, No 2, Apr-Jun 84
(manuscript received 23 May 83) pp 117-127

RODIONOVA, Zh. F., State Astronomical Institute imeni P. K. Shternberg

[Abstract] A cartometric study was made of Venusian relief for ascertaining such morphometric characteristics as the areas and mean elevations of different regions and the surface in general. The measurements were made using the USGS hypsometric map of Venus (1981) at 1:50,000,000 in a Mercator projection covering 93.6% of the entire surface; horizontal resolution about 100 km, vertical resolution about 0.1-0.2 km. A special technique was used in determining the areas and mean elevations of 22 regions on the planet. Hypsographic curves were plotted for the different regions and a map of Venusian relief averaged for 5° grid squares (contours drawn each 0.5 km) was compiled. A table gives the areas and mean elevations of highlands and lowlands on Venus. Mountainous regions occupy 7.4% of the surface; hilly areas -- 54.8% and lowlands 37.9%. The hypsographic curve for Venus is compared with those for Mars and the Earth, constructed relative to the mean level for each planet. On Venus about 40% of the surface is above the mean level, on Earth about 43% and on Mars about 53%. In the northern hemisphere of Venus, plains occupy a greater area (46%) than in the southern hemisphere (30%), the same as on the moon, Mars and Mercury. Figures 5, tables 1; references 8: 4 Russian, 4 Western.
[172-5303]

SYMPOSIUM ON 'COSMOS-1514' BIOLOGICAL EXPERIMENTS

Leningrad LENINGRADSKAYA PRAVDA in Russian 22 Nov 84 p 3

[Article by V. Ovcharov]

[Excerpt] An international symposium which opened in Moscow on November 21 is devoted to results of the space experiment which was performed with the Soviet biological satellite "Cosmos-1514" in December of 1983. Attending the symposium are scientists of the nine countries that took part in the preparation and carrying-out of this project -- the USSR, Bulgaria, Hungary, the German Democratic Republic, Poland, Romania, Czechoslovakia, the USA and France -- and also of the Federal Republic of Germany.

Commenting on the significance of this experiment, academician O. Gazenko, director of the USSR Ministry of Public Health's Institute of Medical-Biological Problems, said: "Unusual passengers -- two monkeys of the macaque family -- were carried in low orbit for the first time by 'Cosmos-1514'. More traditional subjects of our research -- small laboratory animals, fish and plants -- also made the five-day trip into space together with the monkeys 'Abrek' and 'Bion'.

"The scientific program of the experiment called for further study of fine mechanisms of living systems' adaptation to space-flight factors, primarily weightlessness.

"The mechanism of adaptation of organisms to weightlessness during the initial hours and days of a space flight holds a special place among the questions that have not been solved conclusively by science," the scientist remarked. "This pertains to processes so deep that they can be fully studied only in animals. It was 'Abrek' and 'Bion' who were assigned the role of such living models. Effects of weightlessness on embryonic development were studied in rats and fish, and problems of growth dynamics were studied in plants.

"The equipping of the satellite with unique registering and recording apparatus, which was developed by specialists of the countries taking part in the experiment, made it possible to obtain a large amount of valuable information, both during the flight and after it. The processing and analysis of this information have been completed, and all of the participants in the project can draw certain conclusions.

"As for the overall result of the experiment, it consists essentially in the fact that we were able for the first time to record the most elementary changes in physiological functions as living organisms encounter zero gravity. It also became possible for the first time to determine very precisely in what manner and in what order these functions change, and how the mechanisms of living systems' adaptation to unusual conditions subsequently develop. We discovered that different organisms and even representatives of a single species react in different ways to weightlessness, from the standpoint of the time required for the restoration of their functions and the level of this restoration. In other words, significant individual differences in the subjects' reactions to specific factors of space flight were observed.

"Another important result was confirmation of the fact that such fine processes as embryogenesis do not suffer in conditions of weightlessness. Animals that had begun their embryonic development on Earth before the flight were born within the normal time-periods after returning to Earth and have themselves produced new and healthy offspring."

FTD/SNAP
CSO: 1866/55

COMMENT ON ORCHIDS GROWN ON 'SALYUT-6' STATION

Kiev PRAVDA UKRAINY in Russian 11 Nov 84 p 4

[Article by V. Khokhachev]

[Excerpt] White and rose-colored orchids adorn a large hothouse of the Ukrainian Academy of Sciences' Central Republic Botanical Garden (TSRBS).

Tropical orchids that are natural-born high climbers are of special interest. Growing entirely without soil, they bloom in hollows of trees and on their branches and trunks.

T. M. Cherevchenko, deputy director of the TSRBS, related: "In natural conditions, 65 types of orchids grow on the territory of the Ukraine. They are particularly numerous in mountainous areas of the Crimea and the Carpathians. Orchids develop slowly, however; sometimes 20 years pass between the sprouting of seeds and the flowering of the plants. Therefore they are kept together in groups of 10 to 20 plants in our hothouse, because the plucking of even one flower can harm an entire family."

The Kiyev botanists are devoting much attention to the cultivation of plants in outer space. Such plants could become sources of oxygen on orbiting stations and add color to the everyday life of cosmonauts. A micro-greenhouse, the "Malakhit-2", served as a unique nursery for these exotic plants. The first orchids grown in it withstood the test of prolonged zero gravity on board the scientific research complex "Salyut-6"--"Soyuz". And bright rose-colored bouquets of these 'newcomers from the skies' are blooming in a winter garden on the hilly banks of the Dnepr.

FTD/SNAP
CSO: 1866/55

ARTIFICIAL SOIL FOR CLOSED-ENVIRONMENT PLANT GROWING

Moscow IZVESTIYA in Russian 4 Nov 84 p 4

[Article by N. Matukovskiy, correspondent]

[Abstract] The article records comments of two scientists engaged in the development and testing of an artificial soil for growing vegetables. According to Vladimir Sergeyevich Soldatov, corresponding member of the Belorussian Academy of Sciences and director of the academy's Institute of Physico-organic Chemistry, where it was developed, the artificial soil consists of two types of ion-exchange resins with fillers of 15 types of nutrients extracted from ordinary mineral fertilizers. He mentions that it was part of a spaceship-type closed-environment system in which test subjects conducted a year-long experiment. They grew the vegetables necessary for their diet in the artificial soil.

Candidate of Sciences Denis Vasil'yevich Fedyun'kin of the Institute of Experimental Botany is in charge of testing of the artificial soil for practical applications on Earth. One application being explored is the growing of vegetables on ships. He explained that the soil can yield 10-12 crop harvests before it has to be regenerated with elements. Whereas one square meter of ordinary ground soil yields one kilogram of garden radishes in 70 days, the same area of artificial soil can yield 10 kilograms in 21 days, it is claimed. Fedyun'kin said that a 'garden' with artificial soil which is 8 square meters in area has been installed on the icebreaker "Krasin", and one 20 square meters in area is being installed on the icebreaker "Leonid Brezhnev". The latter is expected to yield 200 kilograms of vegetables in one month. Such ship installations are called "SUVOR", an acronym for 'ship unit for growing vegetable plants.'

FTD/SNAP
CSO: 1866/55

REMOTE SENSING USED FOR STUDY OF FOREST RESOURCES

Moscow EKONOMICHESKAYA GAZETA in Russian No 34, Aug 84 p 16

[Article by A. Metal'nikov, division chief at the USSR State Committee for Science and Technology, V. Yezhkov, deputy division chief, and P.Moroz, chief of the Lesproyekt All-Union Production Association: "From Space to Land"]

> [Text] "The space expedition of the orbiting station Salyut-7 has lasted more than half a year. Manned ships and artifical earth satellites are launched regularly. But what is the practical return to the national economy from the space program that is being carried on?" -- the Afanas'yev family

The vast material and intellectual resources that have been invested in space research have led to the development of many areas of science and technology. Space opens up opportunities that were unknown earlier for the study of natural phenomena and processes on earth .

The practical value of the information about our planet that has been received from space is enormous and of interest to many sectors.

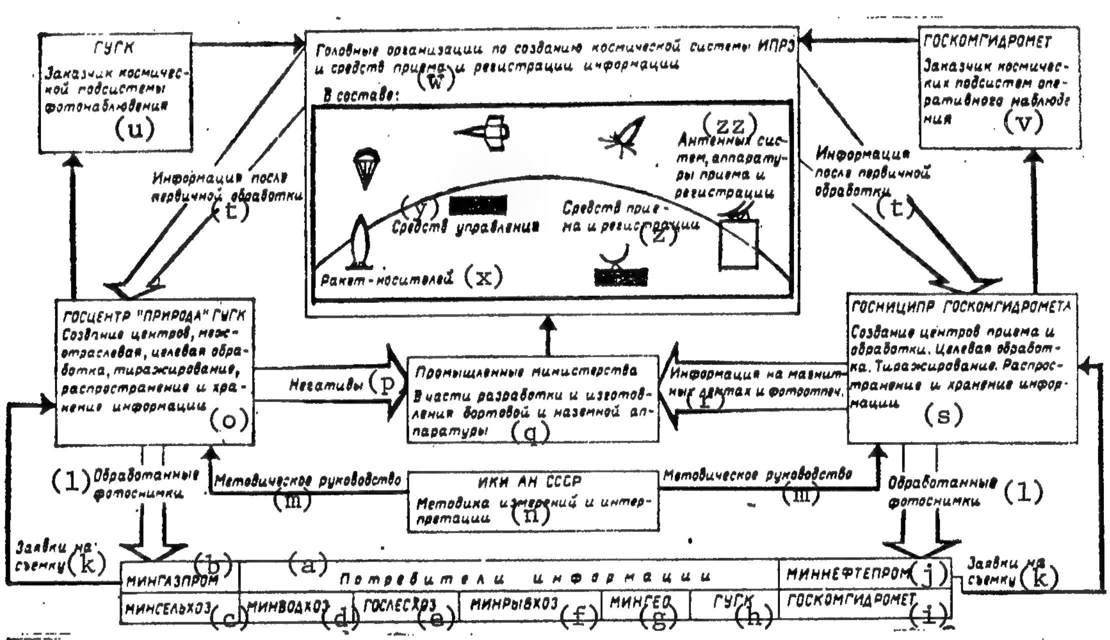
The Soviet Union is setting up a system for study of the earth's natural resources based on the use of space engineering equipment.

The main advantages of space surveying are its global scope and the possibility of carrying on regular observation of the entire land surface of our country. The information received permits both qualitative analysis of images of natural formations in different bands of the spectrum and quantitative data processing by computer. All this makes possible the comprehensive study of the characteristics of natural phenomena in vast areas, and this includes their changes over time.

The space complexes which include the Salyut orbiting stations, the Soyuz manned ships, the Progress transport craft, and various artificial earth satellites play an important part in such research. They carry out different scientific assignments and receive operational and long-term data.

Experience testifies that in any sector a full-fledged analysis of space data is only possible where there is an integrated combination of land and space equipment. This means the interaction of manned and automatic craft with traditional hydrometeorological stations, water gauging posts, and services at monitoring-measuring facilities. It is also necessary to set up a specialized data processing service.

The diagram below shows the structure of the IPRZ [Study of the Earth's Natural Resources] system. Precise, coordinated work by all its elements is an essential condition of its functioning. In this connection the positive experience of organizations of the USSR State Committee for Forestry with using data from remote sensing of the earth is of some interest.



Key: (a) Information Consumers;
(b) Ministry of Gas Industry;
(c) Ministry of Agriculture;
(d) Ministry of Land Reclamation and Water Resources;
(e) State Committee for Forestry;
(f) Ministry of Fish Industry;
(g) Ministry of Geology;
(h) GUGK [Main Administration of Geodesy and Cartography of the USSR Council of Ministers];
(i) Goskomgidromet [State Committee for Hydrometeorology and Environmental Control];
(j) Ministry of Petroleum Industry;

[Key continued, next page]

[Key continued]

(k) Requests for Surveys;

(l) Processed Photographs;

(m) Methodological Guidance;

(n) IKI [Institute of Space Research] of the USSR Academy of Sciences -- Methodology of Measurement and Interpretation;

(o) "Priroda" [Nature] State Center of GUGK -- Establishment of Centers, Intersectorial, Special-Purpose Processing, Publication, Distribution, and Storage of Information;

(p) Negatives;

(q) Industrial Ministries -- in Relation to Development and Manufacture of Onboard and Ground Equipment;

(r) Information on Magnetic Tape and Photographic Prints;

(s) GOSNITsIPR [State Scientific Research Center for Study of Natural Resources] of Goskomgidromet -- Establishment of Receiving and Processing Centers, Special-Purpose Processing, Publication, Distribution and Storage of Information;

(t) Information after Initial Processing;

(u) GUGK -- Purchaser of the Photographic Observation Space Subsystem;

(v) Goskomgidromet -- Requester of Operational Observation Space Subsystem;

(w) Head Organization for Setting up the IPRZ Space System and Equipment to Receive and Record Information, Consisting of;

(x) Transport Rockets;

(y) Control Equipment;

(z) Receiving and Recording Equipment;

(zz) Antenna Systems, Receiving and Recording Equipment;

Special land and aviation equipment has been used in our country to monitor the condition of the forests for many years. Thus, more than 500 airplanes and helicopters are assigned to protect against fires and pests during the summer. More than 160,000 persons are employed protecting our forests.

In order to battle forest fires, which still do a great deal of damage, territorial forest-protection air bases and forestry management organs must have operational data not only on the situation in the burn area but also on the situation in the entire territory under protection. And that is almost 1.3 billion hectares! Traditional methods would be powerless here. Today images arive daily from "Meteor" meteorological artificial earth satellites; these images can be used to assess the fire hazard in the forest, the dynamics of the development of large forest fires, the dimensions of the smoke region, and the density of the smoke. The strategic axes of forest fires are predicted on a more substantiated basis using space photographs and measures are taken to fight them.

The equipment on board the satellites gives data on the form, distribution, and development of the cloud cover and the temperature of the Earth's surface beneath it. All this data forms the basis of contemporary methods for identifying fire hazard.

The strictly documentary character of the images of the earth's surface on the space photographs makes it possible to determine the withdrawal line of the snow cover fairly reliably and to more precisely plan time periods for conducting aerial forest conservation work in the summer and fall. Moreover, these photographs are used for objective evaluation of the basic parameters of the resource cloud cover, which is being used to extinguish forest fires by cloud seeding, and to identify storm clouds on time.

Operational evaluation of the meteorological and fire situation using space photographs, supplemented by data from the local areas, helps maneuver aviation forces and firefighting resources rapidly and accurately.

Materials from spectral-zone and multizone space photography by " osmos" artificial earth satellites and the "Salyut" station scrupulously record the areas damaged by fire. Sections of newly burned out forest are conspicuous on synthesized color multizone photographs. The contrast of the image of burn areas makes it possible to automatically map the contours of burned out forests and determine their area.

In this way a correct evaluation is made of the damage done by forest fires, changes in the condition of damaged areas over time are monitored, development of burn areas into centers of forest pathology is predicted and prevented, and steps toward economic incorporation of damaged sectors and restoration of the forest are determined.

Freshly cut areas, mine excavation sectors, the routes of highways, power transmission lines, and petroleum and gas pipelines, hydro engineering structures, construction sites, blown-down sectors, and forests that have suffered from pests and diseases -- all are recorded in documentary form by space photographs.

Each year in our country we cut up to 2.5 million hectares of forest in the taiga alone. All enterprises must carry out this logging in conformity with the Rules for Principal-Use Cutting, which envision a precise system that takes account of forest growing conditions, the reliability of forest restoration, and preservation of the natural protective functions of forests. The material from space photographs makes it possible to monitor observance of these procedures.

Measurement of the length, width, and area of forests in space photographs is done with great precision. The direction of cutting areas and their position on mountain slopes, which is especially important, are determined exactly.

The method of recording ongoing changes in forest resources caused by human activity and by natural factors based on the used of space photographs is widely employed today.

At the present time the country's forest resources have been studied by ground methods on only about 650 million hectares, some one-half of the total. In 1948-1955 the remaining area -- mainly the northern parts of Siberia and the Far East -- was studied by aerial cruising techniques, which are not highly

accurate. Furthermore, major changes have occurred in these areas in the period since then. The question of another study and mapping of forest resources on a qualitatively higher level is now on the agenda. Space science makes it possible to solve this problem.

The studies that were made demonstrated the effectiveness of using space photographs in recording and inventorying field- and soil-protective planting.

The system of protective forest plantings in the southern regions of the country combined with antierosion methods of soil tillage, highly sophisticated crop farming methods, and hydro structures is helping to raise soil fertility. According to calculations by specialists, establishing forest plantings guarantees an added 10 percent in the harvest. But this effect is achieved where protective plantings are optimally located and kept in good condition.

Space photographs are used to map forested areas, field protective and ravine strips, and planted areas along roads, gullies, ravines, scree fields, and steep slopes. In this way the effectiveness of agricultural and forest improvement measures is evaluated. Space photographs are also being used successfully to recount resources in depleted forest material bases and to determine the hydrological condition of the forests.

Use of materials from aerial and space photographs led to an unprecedentedly sharp increase in the volume of data to be analyzed and processed. However, this flow of data did not catch specialists unprepared. The method of automated interpretation of space photographs is already being used in production. A system of applied programs has been developed. The results of processing are automatically transmitted to the forest planning information system. Combined human-machine methodologies have been developed for recording ongoing changes in forestry resources. They envision automating the preparation of maps, forest planning boards, and plans of forest plantings. Research has begun on machine processing of classification of forest resources.

Remote methods of probing the Earth from space have not only improved the operational efficiency and precision of work on the study of forests and evaluating their condition, but have also reduced the costs of this work.

For example, according to information from the Lesproyekt All-Union Association of the USSR State Committee for Forestry, when reserve forests are inventoried by traditional methods the output per specialist is 34,000 hectares; with the new technology based on space photography it is already 180,000 hectares, 5.5 times greater. And the prime cost of inventorying each thousand hectares has dropped from 235 to 83 rubles. The economic impact is achieved primarily by a significant decrease in forest studies involving travel to the forest. Therefore, the new technology is also changing the nature of forest planners' labor; more and more their main tool is the computer.

We should add that at the same time spacecraft are performing orders for gas and petroleum workers, fishermen, land improvement specialists, geologists, and meteorologists.

The high scientific level of space resource management in the USSR and our rich experience with the use of aerial and space data create a foundation for broad international cooperation in the interests of developing many sectors of the economic activity of different countries. In May-June 1984 a U. N. training seminar on the practical use of remote sensing data in forest management was held in Moscow. Representatives of 22 developing countries of Asia, Africa, and Latin America took part in its work. The seminar, which was highly praised by its participants, was another confirmation of the Soviet Union's readiness to continue to direct its achievements in the conquest of space to service to the world.

12424
CSO: 1866/11

UDC 528.2:629.78

EVALUATING ACCURACY IN DETERMINING POSITION OF EARTH'S CENTER OF MASS AND ELEMENTS OF ORIENTATION OF GEODETIC COORDINATE SYSTEM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 1, Jan-Feb 84 (manuscript received 13 Oct 82) pp 45-49

MASHIMOV, M. M, professor, doctor of technical sciences, and MALETS, K. V., candidate of technical sciences, Order of Lenin and Order of the Red Banner Military Engineering Academy imeni V. V. Kuybyshev

[Abstract] This article represents a continuation of earlier work (M. M. Mashimov, et al., IZV. VUZov: GEODEZIYA I AEROFOTOS"YEMKA, No 5, pp 30-44, 1979; No 2, pp 48-53, 1980) on determination of the earth's center of mass and elements of orientation of a geodetic coordinate system from observations of an artificial earth satellite. The initial equations are written for solving this problem. This involves a functional dependence of the measured parameters $L(\rho, \Delta\rho, \theta, \delta, h, \Delta\tau)$, obtained using the results of rangefinder (ρ), Doppler ($\Delta\rho$), angular (θ, δ), altimeter (h) and radio-interferometer ($\Delta\tau$) observations of satellites (S) from surface stations (Q) and the sought-for parameters -- the initial conditions $\theta_0(a_0, e_0, i_0, M_0, w_0, \Omega_0, t_0)$, the coordinates $R_Q(X_i, Y_i, Z_i, i = 1, 2, \ldots, k)$ of astrogeodetic observatories (AGO) and $r_0(x_0, y_0, z_0, \nu_0, \xi_0, \eta_0)$ -- the coordinates of the earth's center of mass and the orientation of the system of geodetic coordinates. The derived system of equations makes it possible to form a covariation matrix for r_0 and proceed to an a priori evaluation of the accuracy in determining the position of the earth's center of mass and the elements of orientation on the basis of the results of satellite observations. This evaluation requires transformation from a geocentric coordinate system to a system in which the x-axis is directed toward the ascending node of the circular orbit. This makes it possible to obtain results in a form convenient for analysis. Correction equations for the measured distances "astrogeodetic observatory-artificial earth satellite" make it possible to obtain the mean square errors in determining the position of the earth's center of mass and the elements of orientation. Similarly, formulas are derived for the mean square errors in determining these parameters on the basis of the results of Doppler observations of artificial satellites. The a priori formulas derived in the article can be used in evaluating r_0 in the first approximation and for the optimization of measurements. A rigorous formula is given for a full evaluation of the required parameters ($x_0, y_0, z_0, \nu_0, \xi_0, \eta_0$), with allowance for their correlation. References: 4 Russian.
[182-5303]

UDC 528.23

EVALUATING ACCURACY IN ORIENTATION OF TOPOGRAPHIC PHOTOGRAPH AND SATELLITE-CENTERED DIRECTIONS FROM STAR PHOTOGRAPH

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 1, Jan-Feb 84 (manuscript received 21 Jan 82) pp 49-55

SHCHERBAKOV, M. I., candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers

[Abstract] It is necessary to determine the orientation of a space photograph independently of the existence of control points on the planetary surface. The linear elements of outer orientation of a photograph can be found from integration of the differential equations of motion of an artificial planetary satellite and the angular elements of outer orientation can be determined from the stars. This requires that the artificial satellite carry a star camera rigidly coupled to a topographic camera and operating synchronously with it. The required steps are illustrated as an example. The geometrical relationships on a sphere between the elements of outer orientation of the star (α_s, δ_s, γ_s) and topographic (α_t, δ_t, γ_t) photographs and their angular elements of relative orientation (α_{rel}, β_{rel}, γ_{rel}) are examined. On this basis a method is presented for determining and evaluating the accuracy in determining the elements of orientation of the topographic photograph. The limits of variations of the mean square errors with a change in δ_t from -90° to +90° and γ_t in the range from 0° to 360° were determined and are tabulated. After finding the orientation of the topographic photograph it is possible to ascertain the satellite-centered directions to points on the planetary surface shown on the topographic photograph. A final expression is derived for the satellite-centered direction and the procedures for evaluating the accuracy of the satellite-centered direction are outlined. The various conditions governing the accuracy in determining the components of the satellite-centered direction and the direction itself are examined. Figures 1, tables 2; references: 2 Russian. [182-5303]

UDC 528.77

METHOD FOR APPROXIMATING AUTOCORRELATION FUNCTIONS FOR DESCRIBING AREAL PHOTOIMAGE FEATURES

Mosocw IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, Mar-Apr 84 (manuscript received 2 Feb 83) pp 68-72

GAVRILOVA, V. V., senior scientific specialist, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers

[Abstract] The algorithm currently used in the automatic interpretation of features on the earth's surface on the basis of their photoimages is

inadequate due to the procedures used in computing the autocorrelation functions (ACF), a large memory volume being required for the input information. The author has proposed an algorithm advantageous in comparison with the algorithm for computing ACF on the basis of discrete values. Its use in analysis of an image fragment measuring 1 cm^2 made it possible to reduce the computer memory volume by a factor of more than 100. Accuracy in computing ACF was increased by noise elimination. The computed values of the two-dimensional ACF form a matrix of 20 x 20 or 30 x 30 elements. The algorithm given in the article for approximation of ACF was embodied in the computation block for two-dimensional autocorrelation analysis developed on the basis of an electronic computer. The new analyzer was used in two-dimensional autocorrelation processing of half-tone images of cultivated land and forest. The ACF were determined for three angles of image rotation (0, 45, 90°). The approximation algorithm was highly effective. The required accuracy was attained with 5-7 iterations. Figures 2; references: 2 Russian.
[163-5303]

UDC 528:518.681.3

EXPERIENCE IN AUTOMATED INTERPRETATION OF AEROSPACE PHOTOGRAPHS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 5: GEOGRAFIYA in Russian No 4, Jul-Aug 84 (manuscript received 31 Jan 83) pp 63-69

LUR'YE, I.K.

[Abstract] The article describes a software method for use in automated interpretation of aerospace video information, in particular, from a multizonal aerospace survey. The Aerospace Methods Laboratory at Moscow State University has developed two algorithms for solving this problem in two stages. An evaluation of their effectiveness in comparison with the most widely used methods was given by I. A. Labutina and the author of this article in the book ISSLEDOVANIYE ZEMLI IZ KOSMOSA, Moscow, 1981. The first algorithm is for the preliminary classification of multizonal information and evaluating the uniformity of multizonal data. This algorithm for the rapid discrimination of classes (RDC) is used in the breakdown of initial data into a relatively small number of groups, after which each group is regarded as a single object. Use of this algorithm does not require a priori information on these objects other than a multizonal photograph. The second algorithm is a "successive clusterization iteration algorithm" (SCIA). In contrast to the RDC algorithm it requires a definite volume of a priori information on the considered objects. It is necessary to stipulate the standard brightness characteristics of these objects. The algorithm is used in identifying the classes formed by the RDC algorithm with standard objects (called "clusters"), in each iteration evaluating the results on the basis of experimentally determined criteria. Application of these algorithms is discussed in detail. The described automated interpretation method for multizonal photographs can be used in the interpretation of different geographical features when the zonal brightness coefficients are the basic interpretation criteria for an

analysis of the brightness structure of images. The results of automated interpretation of agricultural crops are given as an illustration of the practical use of the method. Figures 3; references: 5 Russian.
[176-5303]

UDC [550.814:629.78]:528.77:550.84.096

GEOINDICATION METHOD FOR INTERPRETING AERIAL AND SPACE PHOTOGRAPHS: STATUS AND PROSPECTS

Moscow SOVETSKAYA GEOLOGIYA in Russian No 8, Aug 84 pp 60-65

MOZHAYEV, B. N., Aerogeologiya (Aerial Geology) Geological Production Association, and ZHUCHENKO, A. G., Uralgeologiya (Ural Geology) Geological Production Association

[Abstract] The article reviews the so-called geoindication method as developed in the USSR with references to the authors of the earliest studies laying the groundwork for this field and with a discussion of the work done and being done by different individuals and organizations. It is emphasized that the geoindication method for the interpretation of aerial and space photographs in all its variants is directed to the solution of practical problems. It is being used successfully in geological mapping, in the search for minerals, in engineering geology and hydrogeological research, in predictive metallogenetic studies, in investigating anthropogenic and natural processes and in solving other economic problems. The practical introduction of the method is favoring optimization of aerospace geological research, the organization of data and collection of new information on geological structure and patterns of distribution of minerals. Progress is being made in the direction of compilation of geoindication maps and forming of new types of data banks. In a number of organizations of the USSR Geology Ministry geoindication research is being carried out at a high scientific level, with a systemic approach, automated processing of materials from aerial and space surveys, use of computers and on-the-ground checking of the results. Unfortunately, further development of the method is being held back by the small volume of research for detecting natural interrelationships which serve as the basis for geoindication. Inadequate attention is being given to the development of the theoretical principles and methodology of geoindication research and no methodological manuals are available. Coordination of scientific research organizations must be improved and it is essential to improve the training of specialists in this field.
[22-5303]

UDC: 552.578.2/.1(575)

NEW METHODS OF RECONSTRUCTING CONDITIONS OF RECENT DIFFERENTIATION OF OIL AND GAS IN THE AMUDAR'YA BASIN (BASED ON RESULTS OF INTERPRETATION OF SPACE PHOTOGRAPHS)

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian No 6, Aug 84 (manuscript received 19 Dec 82) pp 112-122

AMURSKIY, G. I., SOLOV'YEV, N. N. and KUZ'MINOV, V. A., All-Union Scientific Research Institute of Gas, Vidnoye, Moscow Oblast

[Abstract] Results are presented from practically the first experiment on the use of materials provided by satellites to refine the geological structure and recent history of the Dengizkul'-Zevardinskaya zone of oil and gas accumulation in the Amudar'ya oil and gas basin. Three groups of superficially distinct photographic objects are visible on space photographs of this zone, apparently reflecting genetically related geological phenomena and processes, responsible in the final analysis for the formation and specifics of the structure and distribution of accumulations of gas and oil in the subsalt level of this portion of the Amudar'ya basin. Middle scale jointing and its significance in the formation of hydrocarbon deposits is discussed. Some specifics of the structure and the nature of depressions with no outlets are analyzed. Concentric photo anomalies are considered as elements reflecting the recent growth of local structure. The experience of reconstructing conditions of differentiation of oil and gas in the most recent geological stage is described. The data presented confirm the assumptions stated previously by many investigators that gas bearing traps in certain deposits may previously have been filled with oil or vice versa. Migrations of oil and gas at various hypsometric levels and later formations of traps containing independent accumulations of oil are credited for the fact that only accumulations of oil remain in the area which is primarily made up of gas deposits. The use of space materials is found to be useful in studies of the specifics of the structure and formation of oil and gas accumulation zones and even individual hydrocarbon deposits. Figures 3, references: 9 Russian. [10-6508]

UDC 550.343.3

USE OF MOBILE SURFACE STATION FOR SYNCHRONOUS SATELLITE MEASUREMENTS IN SEISMOLOGICAL RESEARCH

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: NAUKI O ZEMLE in Russian Vol 37, No 3, May-Jun 84 (manuscript received 12 Mar 84) pp 47-56

MARDIROSYAN, G. Kh. and MISHEV, D. N., Central Space Research Laboratory, Bulgarian Academy of Sciences, Sofia

[Abstract] During the last 20 years specialists in the USSR and Bulgaria have developed a number of types of seismological stations, many of these

truck- or trailer-mounted stations still being in use. In order to implement the INTERCOSMOS and BOLGARIYA-1300 space programs specialists at the Central Space Research Laboratory, Bulgarian Academy of Sciences, developed a prototype of a mobile surface station for synchronous satellite measurements (MSSSSM), one of the possible variants of the universal mobile laboratory for synchronous and complex space and geonomic research. The articles gives a block diagram of the MSSSSM. The station consists of primary and secondary electric supply systems, measurement instruments, instrumentation for determining position, precise time system, programming device, data collection system, autonomous recorders, radio communication system and auxiliary devices. The instruments include: devices for measuring spectral reflection characteristics, devices for measuring temperature of surface air layer, surface soil layer and vertical temperature profiles, devices for measuring moisture content of soil surface layer and vertical moisture content distribution, instrument for measuring gradient of soil conductivity, instrumentation for hydrological measurements, seismic detectors, magnetometers, counters of aerosol particles and standard set of meteorological instruments. The type, number, structure and arrangement of seismic detectors and the organization of measurements are dependent on the specific objectives of the work and measurement conditions. There is a discussion of the most suitable seismic detectors for different purposes and possible alternative methods for registry of the seismic signal. The different types of field and expeditionary work possible with the station are described. Figures 4, tables 1; references 16: 13 Russian, 3 Western.
[23-5303]

UDC 528.223:550.312

APPROXIMATING PERTURBING PART OF GEOPOTENTIAL BY POLYNOMIALS OF STIPULATED FORM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 3, May-Jun 84 (manuscript received 6 Dec 83) pp 61-66

PLAKHOV, Yu. V., professor, doctor of technical sciences, and PARAMZIN, A. V., graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers

[Abstract] The problem examined is the representation of perturbing potential by a series of coefficients of orthogonal polynomials of a particular type. The objective is to combine the merits of the classical expansion in spherical functions and point models for predicting the perturbed motion of geodetic artificial earth satellites. Although the classical expansion is convenient for analytical integration of the equations of motion, it is very unwieldy in numerical integration, whereas with use of point models the situation is the reverse. The physical validation of the possibility of solving this problem is the adequate smoothness of geopotential at satellite altitudes, characterized by the sum of all the spherical harmonics. A simpler analytical approximation of geopotential is proposed and the

mathematical procedures are entirely obvious. However, in this approximation there is no dramatic decrease in the number of sought-for coefficients in comparison with the number of harmonic coefficients. In the future further progress can be achieved in this direction. In the formulation of the problem the perturbing geopotential is written as

$$R = U - U_0 - R_0, \tag{1}$$

U_0 is the central part of geopotential, R_0 is a reference perturbing potential, including the largest anomalies of the earth's gravity field. R must be approximated as:

$$R = \frac{\mu}{r} \sum_{n=0}^{N} \sum_{m=0}^{M} \sum_{k=0}^{K} f(r) T_n(X_\varphi) T_m(X_\lambda) T_k(X_r) C_{nmk}, \tag{2}$$

Knowing the classical expansion of U and stipulating the form of the polynomials in (2) it is necessary to find a three-dimensional mass of dimensionless coefficients C_{nmk}. A method for accomplishing this is presented. The required C_{nmk} coefficients are determined and an approximation method is proposed. Although the number of C_{nmk} coefficients still remain rather large, suggestions are made as to how the number can be reduced. Figures 4; references: 4 Russian.
[181-5303]

UDC 528.94:528.711.1(202)

EXPERIENCE IN COMBINED SPECIAL MAPPING USING SPACE INFORMATION

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 7, Jul 84 pp 40-44

ASTAKHOVA, V. A., KOZLOV, V. V. and RYABCHIKOVA, V. I.

[Abstract] Several research organizations in the USSR are carrying out experimental work for developing new types of maps for certain regions, including the subarctic region of the Northeastern USSR. In areas such as the latter, inaccessibility and other field work difficulties dictate a heavy reliance on space photographs. Such photographs are used in compilation of preliminary specialized maps; this is followed up by aerovisual observations and on-the-ground investigations in key areas; then field data are processed and final compilations of special maps are prepared with their accompanying legends. The difficulties in visual special interpretation of space photographs peculiar to the investigated area are discussed in relation to the overall objective, i.e. combining the special subject matter maps into one so-called "complex" mapping and the collating and integration of the special content maps which were initially compiled. The difficulties can be overcome in part by compiling intermediate maps of natural complexes and separate interpretations of key elements, such as hydrography, distribution of Quaternary deposits, geological structure as expressed at the surface, etc. A definite sequence for interpretation of space photographs was worked out

(Fig. 1 in the text is a block diagram of these procedures which make it possible to compile collated geological, geomorphological and landscape maps). The intricacies of geomorphological, geological and landscape photointerpretation are discussed. It was found that the geomorphological map is an effective basis for mapping natural resources. Fundamentally new geological information was obtained in the space photointerpretation process that can be used in tectonic regionalization and photogeological work. New peculiarities of the morphological structure of tundra landscapes were revealed. Figures 3; references: 3 Russian.
[189-5303]

UDC: 531.3:574.9

COMBINED ANALYSIS OF THE DYNAMICS OF COMPLEX ECOSYSTEMS BASED ON REPEATED REMOTE MEASUREMENTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 277, No 6, Aug 84
(manuscript received 15 Mar 84) pp 1505-1509

VINOGRADOV, B. V., SHVEDE, U. A. and KAPTSOV, A. N., Institute of Evolutionary Morphology and Ecology of Animals imeni A. N. Severtsov, USSR Academy of Sciences, Moscow; Latvian Scientific Research Institute of Agronomy and Agricultural Economics, Skriveri, Latvian SSR

[Abstract] Experiments have been conducted on combined analysis of the dynamics of complex ecosystems, in order to construct a balanced three-dimensional model of the dynamics of a complex ecosystem under the influence of anthropogenic and other factors. Experiments were performed in a complex forest-swamp-field ecosystem using series of aerial photographs taken in 1956 and 1974, 18 years apart. Thirteen classes of land use were distinguished, allowing 156 theoretically possible forward and reverse transitions. In practice, 46 transitions were observed. A balanced model of the dynamics of the ecosystem is constructed and diagrammed, based on frequencies of such transitions as plowing of natural pastures, clearing of forests, construction of cultural objects, etc. Changes predicted to occur by 1992 include: virtual disappearance of meadows, swamps and swampy forests, great reductions in the plowed areas, great increases in areas covered by conifers and gardens. The extrapolation prediction allows determination of the ecologic and economic results of the dynamics of the complex system: the water supply situation should worsen, particularly during dry years, as a result of draining of swamps; almost no natural pasture land will remain, requiring cultivation of artificial meadows and feed grasses. The major advantage of aerospace photographic monitoring of the dynamics and ecological predictions of complex ecosystems by means of transition matrices is the quantitative expression of their dynamics which results. Figure 1, references 4: 2 Russian, 2 Western.
[14-6508]

OBITUARY OF V.N. CHELOMEY

Moscow KRASNAYA ZVEZDA in Russian 12 Dec 84 p 3

[Excerpt] Academician Vladimir Nikolayevich Chelomey, an eminent scientist and designer in the field of rocketry, died suddenly in Moscow on December 8, 1984, at the age of 70. He was a member of the Communist Party of the Soviet Union since 1941, and a deputy of the USSR Supreme Soviet.

Vladimir Nikolayevich Chelomey was an eminent designer of Soviet rocket technology and aircraft. He carried out important scientific work in the field of mechanics, and he educated numerous scientists and engineers who are working at many institutes and design bureaus.

V. N. Chelomey was born June 30, 1914, into the family of a school teacher. After graduating from the Kiyev Aviation Institute imeni Voroshilov and completing postgraduate studies in the Ukrainian Academy of Sciences, he worked from 1939 on as a scientific consultant and head of a department of the Central Institute of Aircraft Engine Construction, and as chief designer and director of a plant.

For the past 29 years, V. N. Chelomey headed a large scientific research and design organization. His brilliant talent as a scientist and designer, profound theoretical knowledge and great erudition enabled him to establish a highly skilled staff and to carry out complex scientific-technical assignments with success.

For his outstanding service to the Motherland, the title of Hero of Socialist Labor was conferred upon him twice, and he was awarded five orders of Lenin, the order of the October Revolution, and numerous medals. He was a recipient of the Lenin and USSR State prizes.

Signatories: K. U. Chernenko, G. A. Aliyev, V. I. Verotnikov, M. S. Gorbachev, V. V. Grishin, A. A. Gromyko, D. A. Kunayev, G. V. Romanov, M. S. Solomentsev, N. A. Tikhonov, D. F. Ustinov, V. V. Shcherbitskiy, P. N. Demichev, V. I. Dolgikh, V. V. Kuznetsov, B. N. Ponomarev, V. M. Chebrikov, E. A. Shevardnadze, M. V. Zimyanin, I. V. Kapitonov, Ye. K. Ligachev, K. V. Rusakov, N. I. Ryzhkov, L. V. Smirnov, G. I. Marchuk, N. V. Talyzin, A. P. Aleksandrov, I. F. Dmitriyev, V. A. Medvedev, O. D. Baklanov, I. S. Silayev, I. S. Belousov, V. V. Bakhirev, Ye. P. Slavskiy, A. I. Shokin,

S. A. Afanas'yev, B. V. Bal'mont, V. I. Konotop, N. S. Stroyev, V. V. Kozlov, B. A. Komissarov, S. L. Sokolov, S. F. Akhromeyev, V. F. Tolubko, S. G. Gorshkov, V. M. Shabanov, A. A. Maksimov, V. N. Konovalov, A. S. Matrenin, V. N. Ivanov, Ye. P. Velikhov, V. A. Kotel'nikov, V. P. Glushko, V. F. Utkin, V. I. Kuznetsov, D. A. Polukhin, A. I. Kiselev, D. A. Tarakov, G. A. Yefremov. (A photograph of Chelomey is given.)

FTD/SNAP
CSO: 1866/55

ACADEMY OF SCIENCES ASTRONOMY COUNCIL MEETS

Baku BAKINSKIY RABOCHIY in Russian 10 Oct 84 p 3

[Excerpt] A plenary session of the USSR Academy of Sciences' Astronomical Council and a scientific session of Soviet astronomers opened in Baku on October 9.

The plenary session was opened by Doctor of Technical Sciences T. K. Ismailov, general director of the Azerbaijan Academy of Sciences' Research and Production Association for Space Research. E. Yu. Salayev, president of the Azerbaijan Academy of Sciences, greeted the participants on behalf of the republic's scientists.

A survey of academician V. L. Ginzburg was devoted to certain questions of gamma astronomy. A scientific paper on the source of energy of cyclic processes in the Earth's atmosphere and a report on the Astronomical Council's coordinating activities in 1982-1984 were given by E. R. Mustel', corresponding member of the USSR Academy of Sciences and chairman of the council.

Candidate of Physical-Mathematical Sciences S. K. Tatevyan reported on promising programs of scientific research with the aid of specialized satellites in the fields of geodesy and geophysics.

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SOVIET-FRENCH MEETING REVIEWS JOINT SPACE PROJECTS

Riga SOVETSKAYA LATVIYA in Russian 3 Oct 84 p 3

[TASS Report]

[Text] Samarkand, October 2. The Soviet astrophysical station "Astron-1" for the first time made possible studies of stars, pulsars and quasars in the x-ray and ultraviolet band of radiation. This was achieved thanks to special telescopes installed on it, one of which was developed by scientists and specialists of the USSR and France. Results of these studies were discussed at an international conference of specialists of the two countries which ended today in Samarkand.

Also discussed at this meeting were preparations for the flight of two Soviet interplanetary stations in line with the program "Venera-Galley" (Venus-Halley's comet). For the first time in the history of space exploration, they will come near the mysterious Halley's comet and make studies of it. These spacecraft also will continue studies of Venus. This work will be done also with the aid of French instruments installed on the stations.

Scientists of the two countries analyzed results of joint experiments in space materials science and communications, and outlined ways of further expanding and intensifying them.

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FEOKTISTOV RECALLS PERIOD LEADING TO GAGARIN SPACEFLIGHT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Nov 84 p 4

[Article by pilot-cosmonaut, Hero of the Soviet Union, Doctor of Technical Sciences K. P. Feoktistov]

[Text] We work on the first spacecraft.

About 10 or 15 years ago, one could hear the following "version" of the reasons for our success in development of space: we have some fantastic fuel at our disposal which permits us to launch heavy satellites and interplanetary vehicles. But it was not a matter of fuel at all. It was at that time and now mostly the very ordinary--kerosene and liquid oxygen. The following legend also made the rounds: Our Vostoks have some secret principle which has become a decisive contribution to successful flights of the first Soviet cosmonauts. All this now causes even schoolchildren to smile. Of course, there was no secret, although one can say that there was a special principle. Except it was not at all secret and mysterious and was not related to design, but to the ideology of design. This principle consisted in a natural desire for guaranteed support of the success of the flight in all its phases due to the use of the maximum reliable, but simplest possible decisions and already tested schemes and principles. The installed equipment was mainly debugged already. Let us say, the components of the life support system that provide air purification were based on the experience of the submarine fleet. Of course, everything was modified for operation under space flight conditions.

It is sometimes very complicated to find and apply simple solutions. For example, which solution of the landing system is simpler: to eject the cosmonauts from the descending spacecraft with separate landing of one and the other on their own parachutes or to land the cosmonauts directly in the vehicle?

At first the second method seemed simpler: no ejection seat and hatch jettisoning were required. But they were the following arguments: if the descending spacecraft and cosmonaut make a soft landing on parachutes, the weight of the parachute system must be increased considerably.

It may seem strange, but we proceeded toward a complicated solution for total reliability--along with landing the entire descending spacecraft, a version with ejection and autonomous parachute descent of the cosmonaut was adopted (the descending spacecraft had already landed by parachute The same method served as a means of cosmonaut rescue in case of an emergency during the initial phase of the rocket flight. We thus solved a double problem by using this version.

At the end of 1958, the problem of developing a manned satellite was solved "at a high level." All doubts were swept away and development of spacecraft design was begun. Now, besides purely design work, an enormous complex of design problems arose. Korolev himself was at the head of the entire matter, inspiring everyone with his confidence, optimism and energy. We did everything in fantastically short periods.

I myself cannot help but be amazed. The idea was formulated in April 1958. Development of the design was begun in winter. The composition of the equipment was finally selected at the same time and its parameters were determined. The drawings for the body were sent to the shop in the spring of 1959 and the first "metal" appeared in summer and at the end of the year the first electrical mockup of the spacecraft was assembled.

This was essentially a real spacecraft with real equipment, but designed for integrated ground testing of systems. The working documentation was mainly completed by the fall of 1959. Other organizations were then included--special equipment had to be developed and delivered for the spacecraft. Extensive cooperation was organized.

I feel that it was a great achievement of our management. Several tens of plants and design offices were included in the work. The matter was new and hardly understandable for everyone. Communications sometimes had to be organized by all "crafty" methods, even to using personal acquaintances--they did not want to lose time for official correspondence. In 1959 also, the most complicated ground support equipment for the flights was developed. Of course, there were also doubts--could a man fly on a rocket into space and could he be returned from space alive and healthy?

We calculated the g-forces during flight. They were initially considered one of the most important flight factors. It turned out that they did not exceed 4 g's during the launch phase. The descent phase was more complicated. Calculations showed that the loads reach 10 g's upon re-entry into the atmosphere at an angle of 2-3 degrees. However, we knew that a human could tolerate these conditions.

The designers made all calculations on desk calculators, although the slide rule, tested for decades, continued to serve as faith and truth.

Of course, questions also arose on weightlessness. It was unknown at that time how a cosmonaut would tolerate it and whether he would maintain efficiency.

Everyone knew that any person could easily experience brief weightlessness by jumping up and down from a chair. But prolonged weightlessness caused debates. Some even maintained that man could not exist in prolonged weightlessness and would die. We were more optimistic on this account, although there were doubts--would the human organism easily tolerate a constant feeling of falling?

Experiments for weightlessness were begun in the spring of 1960 in a TU-104 aircraft. Utilizing my service acquaintances, I decided to test myself to see what weightlessness was. I still recall this flight with pleasure. The test subjects and experimental animals--a cat and dog--were in the aircraft. What amazed me? As soon as weightlessness occurred for the first time (it lasted for about 30 seconds during one "hump"), I for some reason consciously grasped the arms of my seat in a death grip and only forced myself to release them through an effort of will. But I felt normal. I was even able to relax on the second "hump." I even swam in the cabin on the third "hump."

There were only five test flights of unmanned spacecraft, of which only three made landings. Besides the flights, there was a lot of other test work.

Test stand and aircraft development of individual systems and equipment were conducted at the end of the 1950s and prior to the beginning of 1960. The carrier rocket was tested simultaneously and the operation and interaction of all ground services were organized.

The spacecraft became a reality by the spring of 1960. Of course, it was still unmanned and without a life support system. The first launch occurred on 15 May.

It was not planned to return this spacecraft to earth and no thermal shielding was on it. According to the descent program, it was planned to operate the spacecraft until it burned up in the dense layers of the atmosphere. The spacecraft was injected into orbit and flew well, transmitting the necessary telemetry to earth for 4 days.

I returned from the cosmodrome to Moscow and arrived at the flight control center. I suddenly receive a telegram from Baykonur: the infrared sensor of the orientation system failed during the last 24 hours--the spacecraft cannot return without it. We looked at the telemetry but could find no changes in the operation of the sensor. And we sent the answer--everything seemed to be in order, there were no changes and the spacecraft could be returned by using the infrared sensor. The descent program was transmitted over the radio, the retroengine was fired, but the spacecraft went into a higher orbit instead of beginning to descend. It turned out that the telemetry of the orientation system had actually shown no variations in 3 days--it had failed. But we did not detect this. But we had a solar orientation system as a backup. If we had used it, everything would have been all right. I was very upset.

Sergey Pavlovich acted as if he was almost unconcerned and was even partly glad, having seen in this case proof of the future capabilities of transferring spacecraft into different orbits, that is, to maneuver them. Although,

he probably wanted to calm the others. The next launch of the spacecraft was supposed to be according to the complete program and even with "passengers" on board.

We placed our hopes on the spacecraft. The flight of 19 August 1960 was completely successful. The entire country saw over television and in the movies how Belka and Strelka looked after the flight. The spacecraft had begun to fly.

The flight of the second spacecraft could be regarded as a landmark in development of worldwide cosmonautics. This unfortunately was reflected weakly in the historical literature. Obviously because Vostok would fly within 8 months and this August flight began to be regarded only as a stage of preparation for it. But, incidentally, this was the first satellite with return of animals and generally a returnable spacecraft.

True, in those days or rather several days earlier, the Americans were the first to return the Discoverer satellite to earth. But, first, the Americans returned only a small capsule, weighing about 50 kilograms, rather than an entire satellite. Second, the capsule did not land by itself, but by a helicopter, which caught it on a parachute during descent. And, third, this was the capsule of a photoreconnaissance satellite of clearly military designation (the Americans themselves called the Discoverer a "spy satellite" at that time).

The Soviet spacecraft was a decisive step on the path to Gagarin's flight. Moreover, space medicine had obtained specific data. And confidence was finally acquired even then in the reality of human flight.

The developers of Vostok themselves then became much more confident. It was assumed after the first flight that modification of the spacecraft design, especially in the control and re-entry systems, would be very complicated and prolonged for human flight.

We wanted to do everything as quickly as possible. And we returned to Moscow on the same date of the 25th; I immediately assembled my colleagues in the evening in order to take counsel: how could we proceed to make everything simpler? We were sitting in a large room, about seven or eight of us. We found the solution after about 3 hours. This was one of those rare cases when there were no arguments. Ten p.m. had passed but I telephoned Sergey Pavlovich and requested that he see me urgently. He said briefly: "Come on!" I got into a car and was at his office within about 5 minutes. Nothing was drawn out. There was only a list of items for the 15 main principal decisions and my readiness to comment on them and prove them.

But my impatience was so strong and the question was so important that I risked going to him with only rough drafts. Sergey Pavlovich did not very much like to perceive things orally, but he understood when there was no other possibility and did not force me to write a paper. This saved time. The main essence of our proposals was to reject the supplementary control system on the descent phase (we returned to it only on the Soyuz spacecraft) and to change

the layout of the emergency rescue equipment. In case of emergency of the carrier rocket, it was decided to carry out rescue from an altitude of 4 kilometers and above by separation of the descent module and to land it by the standard scheme. We recognized that there was some risk during the initial launch phase, but a risk justified from all viewpoints. Moreover, the probability of an emergency situation was very low. Having outlined all this, I said to Sergey Pavlovich that if the suggestions were accepted, the number of modifications would be minimal.

6521
CSO: 1866/38

FEOKTISTOV SAYS MANNED LUNAR, MARS FLIGHTS LACK JUSTIFICATION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Nov 84 p 4

[Article by Konstantin Feoktistov: "Seven Steps Into Space"]

[Text] Voskhod

The idea of the first multiplace spacecraft, so far as I know, belonged to Servey Pavlovich Korolev. He suddenly asks once in a conversation with a group of designers: "But is it really impossible to place two or even three cosmonauts in the descent module?" We answered in a friendly manner: "No, it is not possible."

Why did we not feel it was impossible to modify the existing spacecraft and to make it a multiplace? Primarily because the already tested landing scheme--with ejection of the cosmonauts by parachute descent--could not be used. The overall dimensions did not make it possible to place more than one ejection seat in the descent module.

Sergey Pavlovich then left the designers alone. He later returned two or three times to this question and they again convinced him that no, it couldn't be done. But Sergey Pavlovich would not be Korolev if he had dismissed this problem. Perhaps he wanted to see that the designers themselves arrived at the same conviction and found the solution to the problem themselves.

And now in February 1964, he again raised this question at one of the meetings. However, he now adopted a new method of influencing us. Seemingly inadvertently, he said that if two or three persons could be placed in a spacecraft then these could be representatives of different occupations, including perhaps an engineer.

After the meeting, returning to the department, we immediately threw out our suggestions. Everything seemed to come into place: a soft landing of the spacecraft with three cosmonauts and possible emergency rescue schemes during different phases of the flight.

I admit that the dream to fly into space, which had occurred even in childhood, at that time, or rather as soon as we began to design the Vostok, was formulated into a quite specific and passionate desire. However, after Belka and Strelka's flight, I reported to Sergey Pavlovich our suggestions late in the evening on modification of the design of the manned spacecraft. In concluding my report, I prepared this "application": "The risk, Sergey Pavlovich, is still substantial and a young pilot would not want to be exposed to danger. The designers should test the spacecraft or rather I myself." What happened here! Sergey Pavlovich exploded beyond belief and began to scream. The meaning of his indignation was this: this was all nonsense and dilettantism. I left him terribly downcast.

Only after Titov's flight, Sergey Pavlovich suddenly said: "Okay, let us organize a selection." What happened here! We began to compile lists throughout the enterprise, several tens of volunteers were gathered, although most absolutely did not believe the reality of all this. Time passed, but none of us was invited to the committee. The skeptics were triumphant. More than 2 years passed, but nothing happened. I became convinced that Korolev had forgotten about it.

And then February 1964 arrived when Korolev commissioned us to take on development of a three-seat spacecraft. Having understood that our hour had arrived, we quickly began the design. When I reported our calculations and drawings to him and he had fully accepted them, I suddenly said seemingly as an afterthought: we will take this on only if our colleagues are included in the crew. But of course, the argument again arose on the need to have a test engineer on board. And Sergey Pavlovich--he had obviously decided everything long ago--says: "Yes, in a three-place spacecraft of course at least one engineer will fly." We didn't agree on anything precisely at that time, but we seemed to reach a gentlemen's agreement on this question. And about 3 months later, several persons, including myself, at the design office were selected and sent for medical examination.

I am entirely indebted to Korolev for the fact that I was able to fly into space: not only did he release me, but he helped in my struggle with the physicians and training supervisors, who again began to express various doubts before the flight itself--they began to talk about my previous ulcer and eyesight. He arranged special study of my case by Soviet specialists from the Ministry of Health and they made a firm positive decision.

And now the spaceflight was completed--a kind of crowning point of a path of many years. Did I feel that I had achieved my desired goal? I did not feel this at all. Strange as it seems, there was a feeling of happiness before the flight, during the active phase of the flight and during the first minutes in orbit. Then came work. But after landing, it was quite different--a feeling of elation, energy and foretaste of new capabilities. I wanted to begin the Soyuz spacecraft as soon as possible. But of course there was also fatigue. All our crew members sensed and behaved calmly in a situation of universal triumph and did not lose their sense of measure. I returned to my old work, to design matters after a leave.

Will We Fly To Mars?

Let us leave the tale of how the Voskhod and Soyuz and orbital stations of the Salyut series were developed. The more so, since the newspapers, including SOTSIALISTICHESKAYA INDUSTRIYA, have written in detail about the work of prolonged space expeditions.

Let us return to the end of the 1960s, to the time when the manned lunar complex was developed. This was good in itself, but was not an end in itself. Even lunar landings cannot be an end in themselves. The scientific and practical result of the flights is important and only this.

What are the results of lunar expeditions?

A large quantity of lunar soil specimens--approximately 400 kilograms--was returned to earth. It would seem that science had received most important material and that the secret of the origin of the moon should be revealed. But alas this did not occur. Study of the soil yielded little valuable data, but posed an enormous number of new questions.

Of course, the results of the Apollo program cannot be reduced to delivery and analysis of lunar soil. The astronauts placed several sets of scientific instruments, including seismographs which receive data about deformations in the lunar crust, on the lunar surface. However, this is also perhaps not the kind of result which would justify such a great effort.

But, before talking about the development of the Apollo program, we should also recall its indirect yield, that is, the practical results, achieved so to say on the side. This yield is worth bearing in mind in analysis of any large scientific and technical program. Thus, the Saturn-5--Apollo system produced a number of achievements, important for development of different areas of technology, including space rocket technology.

And even so, the main result of the Apollo program, on which approximately $25 billion was spent, cannot be considered from the viewpoint of its further development. And it has not yet achieved any development. Flights to the moon were stopped since 1972 and no return to them is planned even during the 1980s. The unique hardware--rocket and spacecraft, developed according to the program, were essentially not used further. The Saturn-5 was launched only once after this, in orbiting the Skylab station in 1973, and even then without the last stage. The Apollo spacecraft was used three times to deliver crews to this station and again in 1975 for the EPAS [Apollo-Soyuz experimental flight] program. Of course, the lunar lander was not installed in any of these cases.

This is perhaps the greatest cost of the Apollo program. The powerful rockets, the most complicated spacecraft and the production, test and launch facilities, on development of which almost 10 years were expended, were unnecessary.

One frequently asks: when will the Soviet Union send its cosmonauts to the moon? This question arises even if this is prefaced by everything that has been said on the subject.

I answer the question in the same way everywhere--with a question: why do in space what has already been done by others when there is an enormous number of other unresolved problems? If we do this, then it should be at a new, significantly higher level. If we talk about the moon, this means that it makes no sense to send brief expeditions there and with the same radius of action on the lunar surface.

The American astronauts were on the moon up to 3 days and travelled from the spacecraft on the lunar rover at a distance of up to 4 kilometers. But after

everything that has been done, this is very little for modern research problems. If a station had operated on the moon for a month or two and if one could have moved away from the station for tens and hundreds of kilometers, then this would have made sense. But the cost of developing such vehicles would be very high. But modern technology is capable of this task. But no one is now interested simply in engineering solutions: sufficiently practical and significant goals--scientific and national economic--are needed. And these goals are not yet evident in development of the moon. Even more so with respect to the expenditures that would be required.

Thus, no one plans any longer to go to the moon. And the period of intensive study of it using manned vehicles is also past. And automatic stations have not flown to the moon for a long time. Although hardly everything is yet clear about our natural satellite. But for those who dreamed that man, who penetrated space and reached the moon, would then undoubtedly head for Mars, a string of disappointments has come.

I do not feel that a flight to Mars will be made sooner than 10-15 years from now. It hardly makes sense to talk about deadlines in general. And it is not at all a matter of whether technology is capable of this. It is not yet capable, but if there is a need to fly to Mars, the preparation for this flight will perhaps occupy less than 10 years.

Modern technology is quite capable of developing a spacecraft for a flight to Mars. It is a different matter that the goal which would make a flight to Mars necessary cannot really be seen at present. One asks, what goal would justify a flight to Mars?

If automatic vehicles reliably detected signs of life on this planet, but were unable to bring back to earth living specimens or plant organisms suitable for research, there would be a serious basis for sending scientists there. It is known that the genetic code of every living thing on earth is essentially constructed identically. If the genetic code of life on Mars could be determined, if such life were detected, and if it could be compared to terrestrial life, the problem of the origin of life on earth would mainly be resolved. If the codes are different, the hypothesis of the spontaneous generation of life will be confirmed. If they are identical, then the hypothesis of "seeding" will be triumphant. The possibility of solving this basic problem would justify the enormous expenditures which are actually necessary to organize a Mars expedition.

There is essentially nothing impossible for a human flight to orbit Venus and even Jupiter. Although it is much farther from earth than Mars and Venus and would require approximately 2 years to fly there with ordinary energy. About 5 years would be required for the return. But the interest of scientists in this unusual and intriguing planet is very high.

Unlike the desert surfaces of the moon, Mars and Venus, which are somewhat similar to terrestrial regions, Jupiter is more similar to an extinct sun. Landing a spacecraft on this planet will of course never be possible--there is no reason to land since there is nothing solid. And the required energy would

be simply enormous. Satellites of Jupiter are a different matter: there is a large selection of them--at different distances from the surface of the planet, different dimensions and accordingly with different gravitation. And one would like to be on them. But will this occur in the foreseeable future?

6521
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FEOKTISTOV ARGUES AGAINST U.S. SPACE SHUTTLE DESIGN CONCEPT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Nov 84 p 4

[Article by Konstantin Feoktistov: "Seven Steps Into the Sky"]

[Text] Airplane or Rocket?

It is not construction problems alone that are determining the possibilities and economics of future ships and stations. Much will depend on the launch vehicles. Their task is to deliver an object to its "workplace." More precisely, not to deliver but to speed up and "throw" a ship in the necessary direction at the necessary speed. And to get anywhere, the launch vehicle itself must obey the laws of celestial mechanics.

The cost of a launch vehicle as part of the total cost of launching a spacecraft can vary considerably. If it is a series-produced one and the spacecraft itself is unique, the figure is somewhere around 10 percent. If the reverse is true, it can reach 40 percent or more. Where on Earth do you see an object that is so expensive to deliver to the place where it is to be used? This is all because transportation facilities on Earth are used over and over again! A launch vehicle, however, is used only one time.

When space launches were infrequent, this fact attracted no special attention. It seemed normal. As the intensity of the conquest of space increased, however, it became more and more important. The question of reducing the cost of space launches by repeated use of launch vehicles arose quite naturally.

The return of rocket stages can produce an effect from the repeated use of not only the entire rocket, but also of its separate parts and equipment. In addition, it would help in the development of new elements for systems. Let us mention further that the soft landing (with removal to the side) of rocket stages would make it possible to avoid limitations on the economic use of those sections of the Earth--and they are sometimes quite large--where these stages usually fall.

And, finally, as a result of this, space will stop being littered with stages that are absolutely not needed but remain there. Right now there are several thousand burned-out stages (and parts of them) in orbit. Their number continues to grow, although part of the rockets descend from orbit as time passes.

Also, in principle it is possible for satellites and ships to collide with them, although practically this danger is still far in the future. In 25 years of space launches, no collisions have yet been recorded.

Nevertheless, economic estimates show that the optimum decisions still are not on the side of its becoming feasible to save standard rocket stages.

What is the answer to this? Actually, the problem of improving economic effectiveness is becoming very acute for cosmonautics. There is only one path to follow: create special launch vehicles that can be used many times.

At the beginning of the 1970's, a decision was made in the United States to develop the reusable "Space Shuttle" system. A compromise was reached: only the upper, or second, stage would return, without the fuel tanks.

The "Shuttle" is launched with the help of two powerful, first-stage solid-fuel engines (3.7 meters in diameter), as well as the second-stage liquid-fueled rocket engines that are supplied with fuel (liquid hydrogen and liquid oxygen) from a large second-stage tank. First the solid-fuel engines are jettisoned after their fuel is consumed, followed by the empty fuel tank. After this the second stage goes into orbit.

What happens to the jettisoned elements? The tank (8.5 meters in diameter, 47 meters long) is burned up and destroyed in the dense layers of the atmosphere. The bodies of the solid-fuel engines are parachuted into water, into the ocean, and towed to shore, where they are used again after being overhauled and reloaded with fuel.

In any event, this is a compromise in both the technical and economic respects. Judge for yourself: the "Shuttle's" maximum payload ranges from 14.5 to 29.5 tons, and its launch weight is about 2,000 tons, which means that the payload is only 0.8-1.5 percent of the total weight of the fueled ship. At the same time, a standard rocket has a payload of 2-4 percent.

If, however, we look at these relationships without considering the weight of the fuel (it is understandable that a kilogram of fuel and a kilogram of rocket are entirely different matters), the advantage in favor of a standard rocket increases even more, to about 10-15 percent. And then there is the possibility of using even just part of the rocket repeatedly.

The "Shuttle's" second stage is sort of a rocket-powered airplane. Why "sort of"? Because, since it has a wing, this stage descends from orbit like a normal spacecraft and lands without thrust, using only the lift of its swept wing. The wing makes it possible to perform some maneuvers with respect to both range and direction and, in the final account, to make a landing on a special concrete strip.

In connection with this, the second stage's landing speed is much higher than that of any fighter plane: about 350 kilometers per hour.

Right now it is difficult to judge how efficient this system will be. In any case, the technical and engineering difficulties that the "Shuttle's" creators

encountered proved to be greater than had been assumed. The development of the project lasted almost 10 years, and the first test flight was postponed for 1.5 years; it was finally made in April 1981. One of the difficulties was the covering of the craft's hull (and it has a quite complicated shape) with heat-reflecting tiles of various sizes and thicknesses, because at different points on the hull the temperature will be different--ranging from several hundred to almost 1,500°C--as the craft passes through the dense layers of the atmosphere.

When the "Shuttle" was being planned, it was spoken of as something that was needed to supply orbital stations; that is, as a transport ship. As far as its cargo-carrying capacity is concerned, however, it would hardly be suitable for the very large stations of the future. In my opinion, automatic transport ships are more suitable in the current stage of development.

The "Space Shuttle" is being represented largely as a development for the future. This can explain, in part, the repeated postponement of the date for the beginning of the flight tests. They say that the plan embodied in the "Shuttle" is a convergence of rocket technology and cosmonautics with aviation. And this is actually the case. Much aviation experience was used in the creation of the upper stage, although at the same time it is really space and rocket technology.

It still seems to me that the "Shuttle's" high landing speed involves no small risk. Landing without a motor, while gliding, without the possibility of going around again--as any airplane can do--requires the highest skill and attention from the cosmonauts, as well as complicated automatic equipment, which the Americans have created.

Of course, the creation of the "Shuttle" was an impressive engineering achievement for American space-rocket and aviation technology, but to me, nevertheless, this system is economically and technically unjustified. The flights cost too much.

So the question arises: why was the "Shuttle" created? Can it be that there are other important advantages of this system?

After injection, the "Shuttle" system's ship can maneuver in orbit, approach and dock with an orbital station or some satellite, and deliver its payload to the proper place.

But there are still no orbital stations that would need many tens of tons of cargo per year; that is, for now this feature more or less does not justify the work done to create the "Shuttle."

However, it has yet another quality. The "Shuttle's" orbital ship can approach a satellite or orbital station, use a manipulator to put a satellite or part of a station in its cargo compartment, and return to Earth. This can be done for purposes of repair, preventive maintenance, or refitting. This, of course, is an important function.

But how often does this operation need to be done? For a small satellite weighing up to several tons, it is economically unprofitable to perform such an operation. It is simpler to manufacture and launch a new satellite.

There have recently appeared in the press more and more articles stating that the main purpose of the "Shuttle" is military. To deliver into orbit superweapons that have not yet been created but possibly could be. Weapons capable of using lasers, particle accelerators and other scientific achievements to destroy other satellites and airplanes, intercept ballistic and cruise missiles and insure "supremacy in space."

All of this is very sad and has already happened more than once: the newest achievements of science and technology are used to create means of destruction; that is, to make war on people, their creators.

However, the continuation of such games is no longer tolerable. The means of destruction that have already been created are such that, once unloosed, they will almost certainly destroy civilization. It is intolerable that space be transformed into an arena for the arms race, into an area from which danger will threaten the life of mankind.

In the future, when it will be necessary to solve complicated production and construction problems in orbit, much cheaper delivery means will be needed. The "Shuttle" path does not lead to these figures, no matter how the design is improved and no matter what fuel is used.

I would prefer a system that is completely reusable and of the single-stage type. Without a wing. Let us see what it would give us. During injection into orbit, a wing means excess weight and rather noticeable additional aerodynamic resistance. A wing is totally unneeded in orbit. During the return into the atmosphere, it is the part of the ship that is most difficult to shield against heat flows. And a wing begins to play its role only in the very final section of a flight, during the gliding and landing. In connection with this, although descent accuracy is increasing, a ship landing like an airplane cannot land anywhere, but only on special landing strips. Is this necessarily an advantage?

Actually, the "Soyuz" and "Apollo" ships have completely tolerable landing accuracy. When necessary, ships with such aerodynamic qualities can land with accuracy on the order of a kilometer but, in return, at almost any selected place on this planet.

Maneuvering directionally during a descent, which a wing makes it possible to do, is not such an important advantage as to complicate the design of a transport system so much.

Naturally, one can ask, then why did the Americans nevertheless go the "Shuttle" route: a sectional, multistage rocket with a winged orbital ship?

Apparently, when the "Shuttle" project was begun, there existed many attendant factors. And also the fact that from the engineering viewpoint in the early

1970's, it was substantially simpler to realize a "Shuttle"-type project: fewer fundamental difficulties, a high degree of structural perfection of individual parts of the system is not required. Here it is clear what to do. Development is cheaper. And it is possible that the fact that many of the designers who participated in the development of the "Shuttle" came from aviation had some effect.

11746
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FEOKTISTOV DISCUSSES NEED FOR SPACE COLONIZATION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Nov 84 p 4

[Article by Konstantin Feoktistov: "Seven Steps Into Space"]

[Text] Will Man Remain on Earth?

What motivates us? Simple curiosity or the high goals of knowledge and a desire to help mankind? There is no contradiction in that question. Curiosity, be it scientific or simply human, is one of the great moving forces behind any kind of knowledge.

Any natural sphere with which mankind interacts is finite in the spatial sense. With the exception of space, that is, because it is limitless.

Therefore, the conquest of space can be a matter of infinite depth and infinite breadth, limited only by man's fantasies, mind and efforts. And there are many interesting technical problems that can be solved there.

In recent years, thanks to the American Professor Gerard O'Neil there has been discussion of the question of future space settlements, or colonies, in near space. What is O'Neil's argument for the necessity of creating colonies in space? Primarily it is the possibility of solving Earth's population problem with their help.

According to O'Neil's concept, a space colony should be a metal cylinder that is 1 to 6 kilometers in diameter and 3 to 30 kilometers long. Correspondingly, from 100,000 to 20 million people will live in each of them. The cylinder will rotate and, consequently, there will be artificial gravity on the inner surface of the shell that forms it. Here there will be not only living quarters, but mountains, forests, lakes, rivers and recesses in the hull with louvers and reflectors for the controlled admission of sunlight.

Tsiolkovskiy expressed approximately the same thoughts about the possibility and necessity of creating colonies in space. In 1911, in a letter to B.N. Vorob'yev, editor of the St. Petersburg magazine VESTNIK VOZDUKHOPLAVANIYA, he wrote a famous phrase: "Man will not remain on Earth forever, but in his pursuit of light and space will first penetrate timidly beyond the limits of the atmosphere and then conquer for himself all the space near the Sun."

While correctly calling Tsiolkovskiy a man of the future, we must not forget that he could not help but also be a man of his own time, which was the end of the 19th and the beginning of the 20th Century. Although the stage of development of science at that time may not have been infantile, it was still youthful. And, as is well known, that is an age of vacillations and doubts, borrowings and maximalism. And these properties of science at that time could not help but be reflected in Tsiolkovskiy's argument.

That scientist substantiates the inevitability of man's extensive settlement of space and the expansion of the boundaries of Earth's civilization from the viewpoints and on the basis of the concepts of his own era. According to Tsiolkovskiy, three basic causes that will be unavoidable in the future will lead to this situation: an insufficiency of energy on Earth, the threat of overpopulation, and the high probability of a cataclysm.

Almost the same arguments are presented in our time in order to substantiate the main goals in the conquest of space. To them we can add the assumption of the inevitability of extreme pollution of the environment to the point where it is unsuitable for life.

Let us look critically at those basic arguments that are advanced by the advocates of settling in space.

Energy. In Tsiolkovskiy's time there were only a few comparatively low-capacity electric power plants that consumed mountains of coal and rivers of oil, and it was frequently with some difficulty that even the most modest needs of people were met. In connection with this, it would be difficult to dispute the idea of the rapid energy exhaustion of the Earth. But since then, flows of electricity have literally inundated the Earth. It would seem that this argument of Tsiolkovskiy's has been refuted completely. In recent years, however, people have become aware of what an energy crisis is. However, this crisis--as is well known--is largely of an artificial nature and has no direct relationship to the reserves of mineral fuel on this planet.

What do Soviet specialists say about our energy resources? The mineral fuel (or, more precisely, coal) should last for at least 1,000 years. The reserves of nuclear fuel on Earth today are quite large; moreover, we have just begun to master fast-neutron reactors, which are capable of regenerating nuclear fuel. There are also hopes of mastering thermonuclear energy, and inexhaustible and, possibly, cheap source of energy. Add to this that many renewable types of Earth's energy resources (hydraulic energy, in particular) are still far from being used completely. Practically, we have just begun to master tidal energy and the energy of the wind and ocean waves. Finally, solar energy can also be used for Earth's needs, by creating various types of terrestrial batteries and facilities for storing heat, in addition to obtaining energy from orbital solar electric power plants.

Thus, mankind will apparently not be subjected to an insufficiency of energy in the visible future. Actually, it is necessary to think about the excess heat that arises during energy consumption and how to remove it from Earth.

Population. The low standard of living and poor housing conditions of most of the population of even the developed countries quite naturally made visible the imminent threat of overcrowding of our planet in those long ago times. These problems have actually bothered scientists for a long time. It was not so long ago that they threatened us with such figures as 100 or even 300 billion people. That was supposedly how many people there were to be on our planet in 100-150 years. Right now science is inclined to think that a more realistic view of the next few decades is that the population increase will slow down and stabilize at the level of 12-13 billion people. According to the calculations of some specialists, full utilization of our planet's agricultural areas will be sufficient to feed 12-15 billion people, and utilization of all the Earth's estimated resources in the future should be sufficient for 100 billion.

Cataclysms. The probability of a worldwide space cataclysm as the result of a collision between Earth and a large comet or the extinction of the Sun was estimated to be very high in Tsiolkovskiy's time. Now it is considered to be practically insignificant. True, the threat of a social cataclysm--the self-destruction of civilization as the result of a worldwide nuclear war--has not been eliminated. In our opinion, there is a powerful movement of advocates of peace growing on this planet. The Soviet Union, which is coming forward with ever new initiatives on questions of disarmament, is trying to do everything it can so that man's hopes for the elimination of the danger of such an "internal" cataclysm will grow.

Natural Resources. Perhaps the thing that upsets mankind most at the present time is the probability of the rapid depletion of Earth's resources. However, a small number of specialists think that the Earth's natural resources have not been very well surveyed and that the known ones are being used inadequately and irrationally. For example, there exist huge reserves for increasing the degree of utilization of primary mineral raw materials by improving extraction and refining methods, in addition to using secondary raw materials and production by-products. Thus, the problem of natural resources is contiguous with the problem of fighting the pollution of the environment with the the waste products of industrial activity. Both one and the other, obviously, can be solved only after extensive economic and social reorganization on our planet.

Thus, those arguments that Tsiolkovskiy advanced to confirm the necessity of man's spreading into space sound far less convincing from the viewpoint of our present knowledge.

Meanwhile, O'Neil's plan, which appeared not at the beginning of the century or in the 1920's, but in our time, pretends to be not only a technical hypothesis, but also a general prescription for the development of mankind.

Without seeing other possibilities for getting out of crises, O'Neil proposes to look for ways to do this in space. This is reminiscent of the hopes of naive people who are incapable of keeping order in their own home but dream of doing it in a new apartment.

There is no doubt that, sooner or later, man will build large objects in space for the purpose of solving various scientific and applied problems. They will undoubtedly be of great assistance in the solution by mankind of its own terrestrial problems. But they will hardly ever become the basic place and means for the development of terrestrial civilization.

Instead of an Epilog

When I entered cosmonautics, everything in it seemed to me to be considerably simpler. Not in the sense that it was simple to work (the work was much more complicated than now: a different time, different conditions, different requirements), but in the sense that everything in the future seemed more distinct and fully achievable. There was no spaceship, so we made one. Then we made a second, and a third. And in the future there were orbital stations, the Moon, a flight to Mars. At that time I did not doubt that man would fly to Mars at least at the very beginning of the--it seemed--fantastically far off 1980's. Much of what seemed to be realistic in 15-20 years still has not come about for various reasons.

Why? The fact of the matter is that everything turned out to be considerably more complicated, despite the huge increase in technical capabilities, the serious advancement of science, and the great amount of experience accumulated in spaceflight. Also more complicated in the technical respect and from the viewpoint of the dynamics of society's capabilities and needs.

For instance, may it be that we now so frequently talk and think about the future of cosmonautics to no avail? We have passed the 20-year mark, and can it be that all our present ideas are not justified? I like to think that it is not to no avail. In the first place, by looking forward we learned restraint and realism. Secondly, concerning oneself periodically with questions of the future--in general or even only that area in which we work--is totally necessary for a sensible evaluation of present affairs and those goals toward which we are going.

They say that it is no longer as interesting in cosmonautics today. Almost everything that can be done "first" has already been done. The most wonderful things are either far behind us or far ahead of us. That is wrong! The creators of space technology, as before, are faced with tasks that--and this means both today's and tomorrow's--are unusually interesting. Interesting in their novelty and their complexity.

There is the idea of building huge radiotelescopes in orbit. This is a completely real matter. But how to assemble these telescopes up there, in orbit? The highest accuracy is needed. Questions, questions...

Actually, there have been flights into space for barely more than two decades. And, in essence, everything is just beginning...

11746
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U.S., SOVIET SPACE PROGRAM AIMS CONTRASTED

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 84 pp 14-18

[Article by Candidate of Historical Sciences G. S. Khozin: "The U.S. Space Program: A Policy of Confrontation"]

[Text] Space--For Harm or for Good?

In forming their national space programs, states can either give preference to the long-range aims of progress for all mankind or direct their efforts at carrying out short-term political tasks, endeavoring to provide themselves with unilateral military advantages. It is very important whether one or another state is concerned with the ideas of humanism and progress for all mankind or whether it is endeavoring to impede this progress, directing against other states the means available to it, including space technology.

The main goal which is pursued by the Soviet Union in the conquering of space has remained fixed. "Victories in the conquering of space are not only accomplishments of our people but also of all mankind and they serve not war but rather the peace and security of peoples. Here," as was stated in the reply of the General Secretary of the CPSU Central Committee Yu. V. Andropov to an appeal by a group of American scientists and public figures, "...precisely the Soviet Union is the nation which 25 years ago opened the way into space and has been the initiator and participant of all the currently existing international agreements aimed at utilizing space solely for peaceful purposes, for the good of mankind."

Our country is a participant to all the basic international treaties and agreements which establish the principles of the activities of states in the area of research and use of space for peaceful purposes (ZEMLYA I VSELENNAYA, 1981, No 2, p 22; 1984, No 1, p 8.--Editors). In recent years, the Soviet Union has submitted to the United Nations drafts of two important treaties the coming of which into effect could prevent the extension of the arms race into outer space. The consistent policy of the Soviet Union and the other socialist states of using the achievements of space science and scientific-technical progress exclusively for peaceful purposes and in the interests of all mankind reflects concern for the fate of living and future generations. It is wise to recall that at one time K. E. Tsiolkovskiy called for precisely such a humanistic use of space.

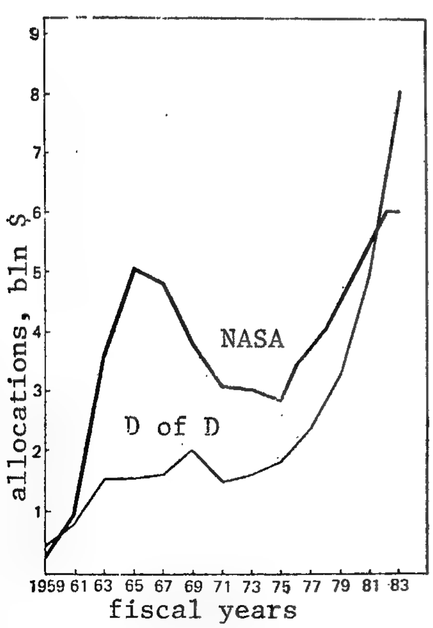
The First Flights--The First Problems

The United States, the leading capitalist power, has organized its activities in space differently. It has become a source of a majority of the crisis phenomena in the world economy, the confrontation trends in international relations and the recidivists of the ideological struggle against the forces of progress.

The history of the U.S. national space program on the development of which some 150 billion dollars had already been spent in 1983 reflects virtually all the contradictions of scientific and technical progress in a capitalist state. For the sake of short-term political, military and economic goals for certain influential monopolistic groupings, space technology has been closely tied to the arms race and has been turned into a tool of competitive struggle within the capitalist camp.

The strongest arguments given in the past by the Republican Eisenhower Administration and the Democratic Kennedy Administration, when the U.S. national space program had just been formulated and the first space projects were being implemented were as follows. In the first place, the United States should restore the prestige of the "leading technological power of the Free World" which had been noticeably shaken as a result of the planned development of space research in the USSR at the end of the 1950's and the start of the 1960's. Secondly, it was essential to improve the military potential of the United States in developing military space technology at a rapid pace. Finally, the task was set of capturing dominant positions on the world markets of space commodities and services by organizing international monopolistic consortiums (of the Intelsat type) in which the United States could determine the conditions (including financial ones) for joint activities related to the production and operation of applied space technology.

Precisely during this period, the typical approach of the United States to implementing major national scientific-technical programs became particularly apparent. The lack of long-range planning and early preparations for the start of work on programs which had no analog in the past was usually compensated for by the creating of an atmosphere of a "moral equivalent of war" around this problem. In essence, this was starkly nationalistic and contradicted a general sense of humanism. In the capitalist countries, this is established when an acute crisis in one or another global problem (the development of space, the world ocean, the energy and mineral raw material problems, conservation of the environment and so forth) requires an extreme (without



Allocations for NASA and Defense Department space projects in 1958-1983 fiscal years

careful planning) switching of significant resources to solving it. Ultimately the aim of such an approach is to quickly achieve a mitigating of the most acute manifestations of one or another global problem. The United States has endeavored to utilize the resources of other countries both in space research and in solving other global problems merely on the grounds that the United States possesses supposedly the most advanced technology. The other capitalist and developing countries are involved in the collaboration under U.S. control in order to carry out the tasks which are pressing primarily for the American monopolies.

"We Are Traveling Together...."

By the mid-60's the United States had already formulated the basic principles for collaboration with other states in the research and use of space and in addition the organizational forms and methods for implementing these principles in practice. In contrast to the Soviet Union, the United States did not want to put space technology into serving mankind but endeavored to utilize as quickly as possible the unique scientific or technical achievements for obtaining a maximum benefit.

The experience of the 1970's eloquently showed that the development of positive trends in international relations involving, first of all, the establishing of the principles of equality and equal security had had a beneficial influence on the development of international collaboration in the research and use of space. Suffice it to point out that during all the 1970's the U.S. government refrained from developing an arsenal of space weapons although it did continue experimental design work in this area.

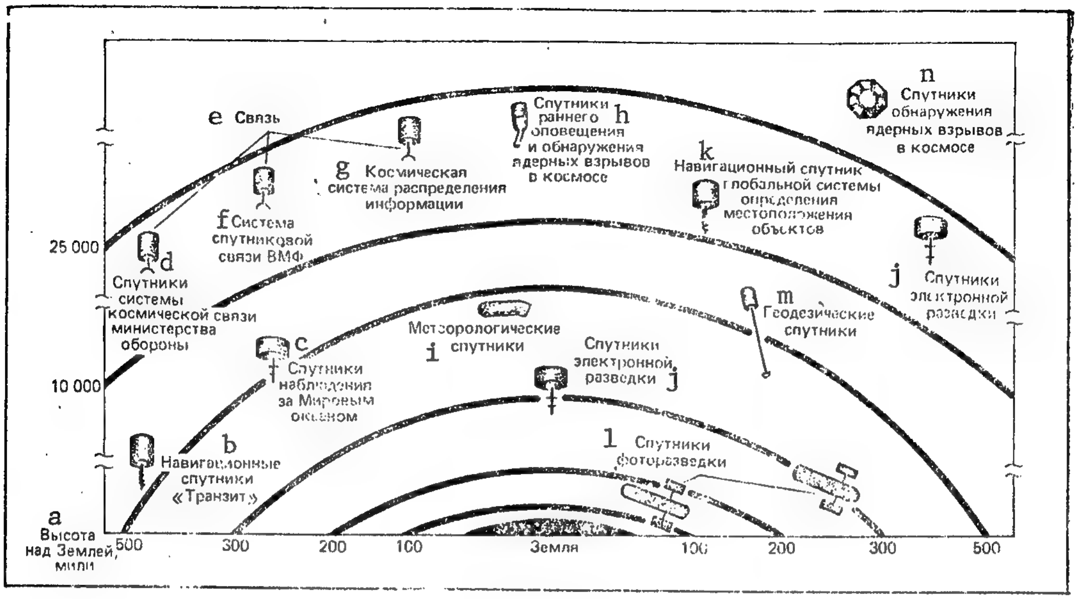
Precisely during the period of the normalizing of Soviet-American relations and the international situation as a whole, major projects began to be discussed related to the conquering of space (for example, the project for an orbital station which would employ specialists from many countries).

Such a constructive approach to international collaboration made it possible to assess many statements by bourgeois scientists and politicians as conforming to the real demands of the times. For instance, take the frequently repeated statement in the West by the U.S. representative in the United Nations, A. Stevenson, made by him in 1975: "We are traveling together, passengers on a small spacecraft, consuming precious reserves of air and soil; the security of all of us depends upon peace onboard this ship and we can preserve ourselves only by endeavor, hard work and, I would say, a love for our fragile ship." The ideologists of capitalism have injected completely definite class sense into such arguments.

A Road to Nowhere...

The fact that world cosmonautics has developed up to now primarily due to the efforts of two states, the USSR and United States, has imposed a particular responsibility on them for future activities in space which should be inseparable from the progress of civilization as a whole. However, recently the philosophical and political views of the modern Republican Administration have assumed a particularly evil cast. It is no accident in dealing with research

and use of space the Reagan Administration has made an abrupt turn toward intense militarization of the space program having set out to develop a space weapons system.



Military space systems operated by the U.S. Armed Forces (diagram from the bulletin DEFENSE MONITOR).
The diagram does not show the operating zone of the manned Space Shuttles which also carry out military missions (an altitude of around 200 miles) and the area of the probable placing of the orbital antimissile defense system (a height of 400-500 miles).

Key: a--Height above ground, miles;
b--Transit navigation satellite;
c--Satellites monitoring the world ocean;
d--Defense Department space communications system satellites;
e--Communications;
f--Navy satellite communication system;
g--Space data disseminating system;
h--Satellites for early warning and detection of nuclear explosions in space;
i--Meteorological satallites;
j--Electronic reconnaissance satellite;
k--Navigational satellite for a global system of determining the location of objects;
l--Photoreconnaissance satellites;
m--Geodetic satellites;
n--Satellites for detecting nuclear explosions in space.

Basic Tasks of U.S. National Space Program

Tasks formulated by the 1958 national law on aviation and space research	Tasks formulated by the Reagan presidential directive of 4 July 1982
U.S. activities in space will pursue peaceful goals in the interests of all mankind. They will be conducted in such a manner as to materially contribute to the carrying out of the following tasks: --Broadening knowledge on the processes and phenomena in the atmosphere and space; --Improving the technical characteristics of aircraft and spacecraft; --Determining the long-range opportunities which could be opened up as a result of space research; --Maintaining U.S. leadership in aviation and cosmonautics; --The most rapid turning over of the results of research of military significance to the Defense Department organization; --Assistance to U.S. collaboration with other countries and groups of countries within the limits outlined by the current law; --Providing conditions for the most effective use of the scientific and technical resources of the state.	The presidential directive confirms that the research and use of space will serve the well-being of the following goals for the U.S. space program: --Strengthening U.S. national security; --Ensuring U.S. leadership in the research and use of space; --Obtaining economic and scientific benefits from the development of space; --Increasing the financial contributions of the U.S. private sector to the space program and the broadening of its participation in work on the study and use of space and introducing the other achievements of the space program into practice; --To help the development of international collaboration conforming to U.S. national interests; --Collaboration with other states and the maintaining of freedom of action in space which would strengthen the security and well-being of mankind.

A militaristic bent has constantly been present in the U.S. space program over all its history. But no previous administration had determined to begin developing several weapons systems immediately which would be used for deployment or combat employment in space. Up to the beginning of the 1980's, with the aid of military space systems, various information was basically collected and disseminated (satellites for communications, reconnaissance, meteorology, navigation, geodesy and so forth) while work on developing space weapons remained within the confines of exploratory scientific research and development.

Now the situation has changed. The Reagan Administration has stated its intention to develop an arsenal of space weapons or various devices for hitting other objects in space from space, from onboard an airplane or from the ground. Testing is already underway for a system for hitting space devices in low orbits. This is a two-stage, solid-fuel missile with an infrared guidance system and a charge of conventional explosives. The missile is launched from an F-15 fighter bomber.

Plans have been announced for "increasing the invulnerability" of space systems which support the combat operations of armed forces. The first of them is a "multilayered" Milstar system of military space communications and it should be utilized in the event of the employing of nuclear weapons in space. This system has already received from the federal budget allocations of hundreds of millions of dollars. Finally, a program has been announced under which a system of space-based antimissile defense (ABM) will be developed and this will be capable of ensuring the "dependable" defense of U.S. territory from a nuclear missile attack. Here the Western European allies of the United States will remain unprotected. Moreover, measures have been taken to increase the effectiveness of observation and early warning space devices.

In contravention of current international treaties and agreements, intensive scientific research has been started aimed at developing space-based weapons systems, including laser and "beam." A Space Command has been established in the U.S. Air Force and this has been entrusted with coordinating all actions related to the use of space for military purposes. A group for interagency coordination has been set up in the upper echelon of the U.S. state system and it is directed by the presidential assistant for national security. This group is responsible for a thorough analysis and report to the president "on the main questions of space policy with the aim of his taking the corresponding decisions." All space systems now in operation, regardless of their organizational affiliation, at present are more closely tethered to the interests of the military department. This is particularly true of the Space Shuttle.

What Is Awaiting Space?

At the start of the 1980's, the United States initiated an unprecedented propaganda campaign which should establish among the public the impression that in the near future cosmonautics should have almost exclusively a military focus. The books published in recent years in the United States discuss in greatest detail precisely the prospects for the use of space for military aims. Among such books are "The Nature of Future Wars" by D. Baker, "Space Warfare" by D. Ritchie, "Confrontation in Space" by G. Stein and "Warfare in Space" by G. Cannon. They all actually establish the thesis that progress in cosmonautics at the beginning of the 1980's has made it possible to turn to developing weapons systems designed for deployment and combat employment in space, both at present and in the 21st Century. Never before in the United States has such a quantity of books been published simultaneously devoted to the development of military cosmonautics and ignoring the role of "conventional" but so essential space research for mankind.

In the current American space program there is a growing trend toward confrontation and toward violating the existing organizational forms and methods for international collaboration in research and the peaceful use of space. The position is an extremely dangerous one for space can actually be turned into an arena of the arms race and cease serving progress. This concern is shared by many Americans, including influential politicians. For example, on 4 July 1982, when President Reagan proclaimed his "space directive," the Senator from Hawaii S. Matsunaga wrote in the Washington Post: "Our most favorable--and probably the last--opportunity to achieve an acceptable agreement with the Soviet Union to all appearances is on the brink of being lost even before we

are fully aware of it. At the same time that the disarmament talks must be continued without fail, the greatest opportunities are being opened up not in the narrow conference halls but in the expanses of space.... Tom Stafford stated that in opening the hatch of the spacecraft Apollo, he believed that a new era was starting in the history of mankind on the earth. We need to give the Staffords and the Leonovs of this planet one more chance."

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INMARSAT MARINE SATELLITE ORGANIZATION

Moscow RYBNOYE KHOZYAYSTVO in Russian No 3, Mar 84 pp 45-48

[Article by V. Ye. Anoshin, Morsvyaz'sputnik, and Candidate of Legal Sciences K. A. Bekyashev, TsNIITEIRKh: "The International Organization of Marine Satellite Communication"]

[Text] Swift growth of human activities in the World Ocean is leading to a significant increase in the volume of information transmitted via radio communication channels. Thus beginning in 1968 the increase in radio traffic volume in the world's marine communication channels increased annually by an average of 5-10 percent for telegraph and by up to 20 percent for telephone. This led to a significant overloading of the frequency bands allocated to traditional marine communication.

The experience of operating different satellite communication systems has shown that use of space technology is now the most promising direction for development of radio communication and radio navigation at sea. Moreover space data transmission systems make it possible to significantly reduce the time required by the specialists of search and rescue services to receive a disaster signal and determine the coordinates of the location of a mishap, which is important to effective rescue activity and man's safety at sea.

These causes compelled the International Maritime Organization to begin studying, in the mid-1960s, the problem of using artificial earth satellites for the needs of marine navigation. The fundamental documents of the new international organization were drawn up under the guidance of the IMO Subcommittee for Radio Communication with the active participation of the USSR--the Convention and Operating Treaty on the International Organization of Marine Satellite Communication (INMARSAT), adopted in 1976.

The INMARSAT convention went into effect on 16 July 1979, and since that time the organization has been functioning officially. But INMARSAT did not begin its practical operational activities until 1 February 1982.

As of 1 September 1983 INMARSAT had a membership of 39 states, to include: socialist--USSR, Poland, Bulgaria, North Korea; capitalist--USA, Great Britain, Norway, Japan and others; developing--India, Liberia, Algeria and others.

Authorized organizations, departments or companies of these countries serve as participants of the operating treaty on INMARSAT (the interests of the USSR, as well of the Belorussian and Ukrainian SSRs are represented in INMARSAT as equal members by the All-Union Morsvyaz'sputnik Association).

According to Article 3 of the convention the objective of INMARSAT is to provide the space segment required for improving marine communication and to thus promote satisfaction of the demands of seamen for improved communication resources, improvement of navigation safety, preservation of human life at sea, maintenance of the effectiveness of shipping and improvement of fleet control.

INMARSAT is guided by the following in its activities: the principles of universality and nondiscrimination, in accordance with which all states and their vessels may use satellite communication, and every state is entitled to become a member of INMARSAT; the principle of maintaining peace and international security, in compliance with which the organization conducts its activities exclusively for peaceful purposes; the principle of sovereign equality of states, in accordance with which all members of INMARSAT enjoy identical rights and responsibilities, irrespective of state structure and prosperity.

Besides the principles written into the convention, INMARSAT follows the principles of the U. N. Charter and the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies of 1967 (contained in the preamble of the convention).

The main organs of INMARSAT are the assembly, the council and the directorate.

The assembly is the organization's supreme organ in which all member states are represented. It determines the policy and forms of activities of INMARSAT, and it elects an additional four representatives to the council. The functions of the assembly include examining and studying the activities, general policy and long-term objectives of the organization. On the council's recommendation the assembly grants permission to create additional possibilities in the space segment.

The assembly convenes its sessions once every 2 years, while special sessions may be convened at the request of one-third of the states or the council. Three regular sessions have been held as of 1 January 1984.

The council is the executive organ of INMARSAT. Its composition includes 22 representatives from among the participants of the operating treaty: 18 representatives from among participants or groups of participants that are not represented in some other way, that have consented to group representation and that enjoy the greatest proportion of votes in the organization; four representatives from among participants elected by the assembly, without regard to their proportional participation, with the objective of insuring the principle of just geographic representation, with due consideration for the interests of developing countries.

INMARSAT's constituent act allows several countries to unify and to appoint one representative paying membership dues on a general proportionate basis. As an example the USSR, the Ukrainian SSR and Belorussian SSR designated the All-Union Morsvyaz'sputnik Association as their participant (it carries 14 votes in correspondence with the dimensions of its proportionate membership dues). The Netherlands and Belgium have formed one group, and Sweden and Finland have formed another, each group having one representative and correspondingly 3.5 and 2.5 votes.

The council's auxiliary organs include committees for technical, operational and financial problems.

INMARSAT is financed through membership dues. Each participant of the operating treaty covers the organization's need for capital in proportion to its membership dues, which were established empirically in the initial phase of the organization's creation; after the first 2 years of the INMARSAT system's practical operation and annually thereafter, the dues will be determined in proportion to the actual amount of use made of the system by vessels of the member states. As compensation for invested capital and a reward for its use, the investing participant receives assets on the basis of terms set forth by the council.

The proportionate dues of the members are regularly reexamined, and they go into effect 1 year after the proportionate dues are first determined on the basis of the amount of use made of the system, with a consideration for the amount it had been used by all participants in the previous year, and from the moment that the operating treaty goes into effect for a new member or the moment some participant leaves the organization or cancels its membership.

As of 1 October 1983 the proportionate participation in the capital of INMARSAT was (percent): USSR--14.07801; USA--23.34024; Great Britain--9.88140; Norway--7.87029; Japan--6.99212; Poland--1.67602; Bulgaria--0.27176; Tunisia--0.05000.

INMARSAT's maximum capital is now $300 million.

O. Lundberg, the organization's general director, stated: "INMARSAT can offer communication services to the entire marine community. Such communication offers many advantages including high speed, quality and reliability, which cannot be insured by traditional communication. We can offer the world community practically all forms of communication that are used on earth. I can confidently predict that the day will come when practically all vessels will be using the advantages of marine satellite communication."*

There are now over 2,000 vessels in the world, including 40 fishing vessels, outfitted with the appropriate apparatus for INMARSAT satellite communication. In Lundberg's opinion over 10,000 vessels will be using the services of INMARSAT by 1990.

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* OCEAN VOICE, April 1982, p 2.

The future use of the INMARSAT system by vessels of the fishing fleet has special significance. Fishermen at fishing grounds could establish communication efficiently, including by telephone, with the ship owner and relatives. The INMARSAT system can be used to efficiently transmit information to vessels when fish accumulations are detected, and especially in cases where it is impossible to insure good quality communication in the short-wave band. INMARSAT is capable of providing practically worldwide communication for the world fleet--that is, communication from any point in the World Ocean (except in polar regions). Therefore it is no accident that Japan has adopted a program for outfitting its large trawlers, refrigerator ships and processing ships with INMARSAT equipment in the immediate future. In the opinion of Japanese specialists this measure will promote both an increase in the catches and the quick sale of products acquired at sea.

By 1985 25 percent of fishing vessels with a cargo capacity of over 1,000 tons are to be equipped with onboard stations permitting utilization of the INMARSAT satellite communication system, while by 1995 this figure is to climb to 40 percent. Because of difficulties of installing antennas with significant gain, there are no plans for installing satellite communication apparatus aboard fishing vessels with cargo capacities from 300 to 1,200 tons.

The INMARSAT system includes a space segment, coastal ground stations, shipborne stations and a control system.

INMARSAT may own or lease the space segment. The space segment of INMARSAT may be used by vessels of all countries on prearranged terms. In determining these terms, the council must not discriminate on the basis of nationality.

In each specific case the council may grant permission for use of shipborne stations at installations that are not vessels but which are operated in the marine environment, when the work of such stations does not seriously encumber services to vessels.

All applications for use of the space segment of INMARSAT are submitted to the organization by the participant and, in the event that the territory under consideration is not within the jurisdiction of the participant, by an authorized electric communication organization. A permit is issued by the organization in accordance with rules established by the council.

Each participant or authorized electric communication organization granted permission to use INMARSAT's space segment bears responsibility for compliance with all of the established terms of use. This provision is applied when an application is submitted by a participant representing a party which does not assume responsibility for permits issued to all or some ground stations that are not owned by this participant or not operated by him.

The organization's permission is required for the use of INMARSAT's space segment by all ground stations. Applications for such permission are submitted by the participant of the party possessing the territory upon which a permanent ground station is or will be located, by the party itself or a participant appointed by the party, with the permission of which shipborne stations

or the ground stations of installations operated in a marine environment are allowed to function. Each party submitting an application bears responsibility before the organization for compliance of the stations with the procedures and rules of work.

In 1979 the World Administrative Radio Conference allocated the 4-6 GHz band for marine satellite communication.

Three types of satellites are being used in the first generation of the space segment--both operational and reserve (Figure 1), launched into geostationary orbit: Marisat (launched 1976, providing for 7-10 communication channels), Mareks (launched 1981, providing for up to 40 communication channels), Intelsat Y-MCS (launched 1982-1983 and providing for up to 30 communication channels).

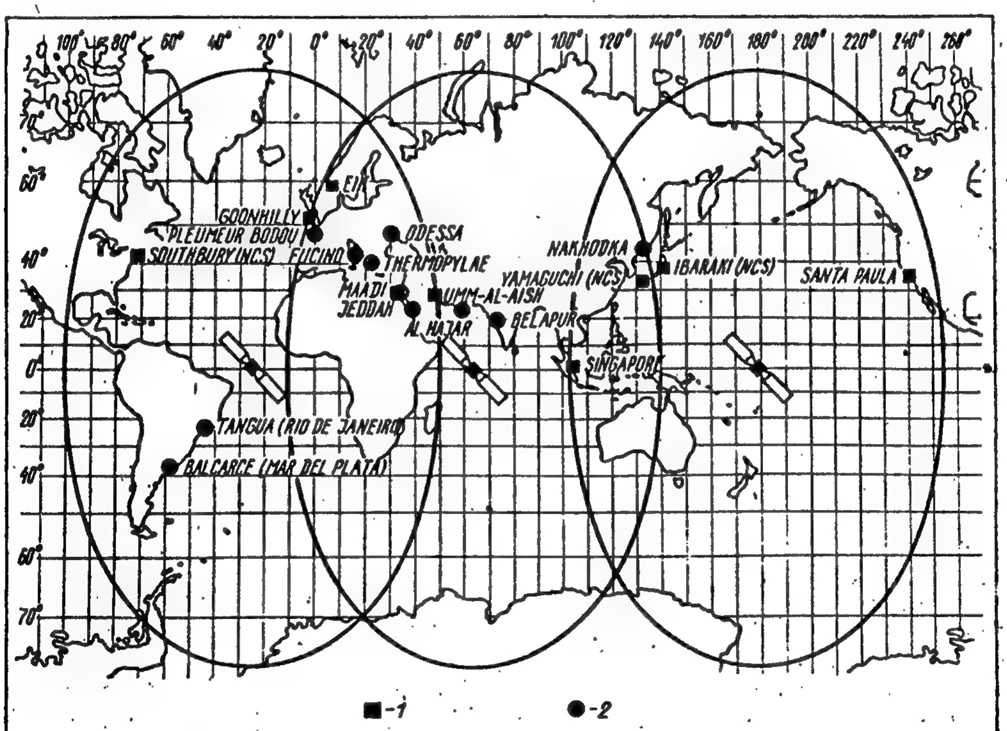

Figure 1. Territory of World Ocean Covered by the INMARSAT System's Satellite Communication: *1*--operating stations, *2*--planned stations

INMARSAT has now developed the technical requirements on second-generation satellites (see Table). Proposals for signing contracts to launch satellites have been submitted by the USSR, the USA and France. Second-generation satellites will have 125 or more channels for operation in the shore-to-ship direction. Various technical procedures can be applied to increase the number of channels to 250. There will be about 250 channels in the reverse direction.

Ocean Regions	Satellite Function	Position in Orbit	Three-Region System (launch Date)	Four-Region System (Launch Date)
Eastern Atlantic	Operational	11.0-19.0° E. Long.		August 1988
Central Atlantic	"	25.5-27.5° W. Long.	August 1988	
	Reserve	"	December 1988	December 1988
West Atlantic, Indian Ocean	Operational	50.0-58.0° W. Long		January 1981
	"	62.0-69.0° E. Long	July 1988	July 1989
Pacific Ocean	Reserve	"	January 1990	January 1990
	Operational	176.0-179.0° E. Long	October 1990, July 1991	October 1990, July 1991

Use of the space segment is presently paid for on the basis of the following rates: $2.40 for 1 minute in telegraph-telex mode; $5.25 for 1 minute in telephone mode; $8.00 for 1 minute of high-speed transmission; $7.20 for a 1-minute conference call. Other rates may be set for organizations that are not participants of the INMARSAT operating treaty.

Shore-to-ship calls are paid for by the calling party, while ship-to-shore calls are paid for by the ship owner.

According to INMARSAT data the volume of correspondence transmitted via satellite communication in 1 minute in 1982 was 2.1 million minutes for telephone and 3.3 million minutes for telex.

However, a fee is not paid for use of the space segment of INMARSAT to transmit an initial distress signal. By decision of the council a fee is not paid for use of INMARSAT's telephone channel to coordinate work during the testing of distress indicator buoys that are an element of the satellite system being presently created to support search and rescue operations at sea. The capabilities of this system essentially include guiding the appropriate rescue service to the location of an emergency radio buoy by way of a satellite communication system and simultaneously processing up to 20 distress signals.

Coastal ground stations are being built and operated by participants of the organization in accordance with INMARSAT's technical requirements. According to Paragraph 3, Article 7 of the convention, ground stations which are located on land, which operate by way of the space segment of INMARSAT and which are located within the confines of land under the jurisdiction of some party are owned solely by that party or by organizations within its jurisdiction.

The main function of coastal ground stations is to provide for communication with vessels by way of satellites and to insure interaction with national and

international communication nets. Every coastal ground station provides for telephone and telex communication channels.

The following frequency bands are recommended for the work of coastal ground stations: for transmission to a satellite--6,410-6,425 MHz; for reception from a satellite--4,180-4,200 MHz. As a rule coastal ground stations consist of a parabolic dish antenna with a diameter of 10-13 m, constantly aimed at an operating satellite above the given ocean region; transceiving equipment; a processor controlling the work of the station.

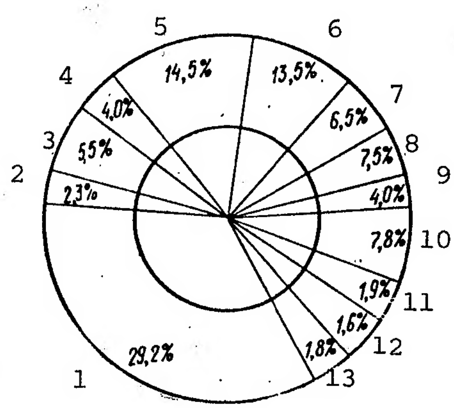

Figure 2. Distribution of Shipborne Stations as of 1 July 1983

Key:

1. Tankers
2. Barges
3. Seismic vessels
4. Yachts
5. Others
6. Bulk carriers
7. Containers carriers
8. Vessels carrying general cargo
9. Gas carriers
10. Petroleum extraction rigs
11. Fishing vessels
12. Research vessels
13. Passenger vessels

Eight coastal ground stations have been placed into operation as of 1 November 1983 at the following locations: Eik (Norway), Ibaraki, Yamaguchi (Japan), Singapore (Singapore), Santa Paula and Southbury (USA), Goonhilly (Great Britain) and Umm-Al-Aish (Kuwait). Two stations will soon be placed into operation in the USSR--at Odessa and Nakhodka.

Shipborne stations are satellite communication terminals that are acquired or leased by individual ship owners or operators from the companies that built these stations or the appropriate ship equipment. They operate at 4-6 GHz.

The distribution of shipborne stations is shown in Figure 2.

An operations control center that functions around the clock was created for technical management of the INMARSAT system. The operations control center

monitors the technical parameters of the space segment under normal operating conditions; it implements back-up and transitional plans; it coordinated tests for the approval of specific types of shipborne stations; it coordinates the testing of new coastal ground stations; it evaluates the results of tests and grants communication network coordination stations, coastal ground stations and shipborne stations access to the space segment of INMARSAT; it provides operating information to communication network coordination stations and to coastal and shipborne ground stations.

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LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters Apogee	Perigee	Period	Inclination
18 Oct 84	Cosmos-1606	678 km	649 km	97.7 min	82.5°
31 Oct 84	Cosmos-1607	280 km	256 km	89.6 min	65°
14 Nov 84	Cosmos-1608	275 km	205 km	89 min	70°
14 Nov 84	Cosmos-1609	385 km	208 km	90 min	73°
15 Nov 84	Cosmos-1610	1,027 km	987 km	105 min	83°
21 Nov 84	Cosmos-1611	326 km	181 km	89.3 min	64.8°
27 Nov 84	Cosmos-1612	1,231 km	130 km	98.1 min	82.6°
29 Nov 84	Cosmos-1613	382 km	209 km	90 min	72.8°
14 Dec 84	Molniya-1	40,900 km	461 km	12 hrs 17 min	62.8°
		(Communications satellite for long-distance telephone and telegraph service and transmission of Central TV programs to points in the "Orbita" network)			
15 Dec 84	Vega-1	(Automatic interplanetary station for exploration of Venus and Halley's Comet)			
19 Dec 84	Cosmos-1614	(No orbital parameters given; "after completion of the flight program 'Cosmos-1614' performed a controlled descent in the atmosphere and landed in the planned area of the Black Sea")			
20 Dec 84	Cosmos-1615	501 km	437 km	93.9 min	65.9°
21 Dec 84	Vega-2	(Automatic interplanetary station for exploration of Venus and Halley's Comet)			
9 Jan 85	Cosmos-1616	381 km	180 km	89.8 min	64.9°

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END